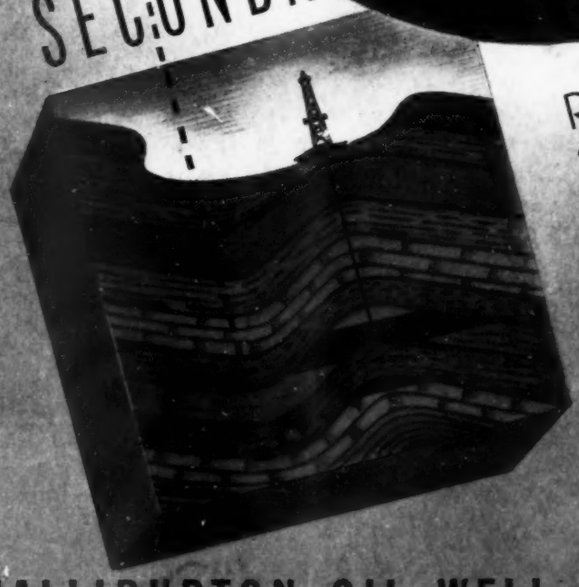
DRILLING AND PRODUCTION | PIPE LINE | REFINING NATURAL GASOLINE

SECONDA… …S AND REPAIRS



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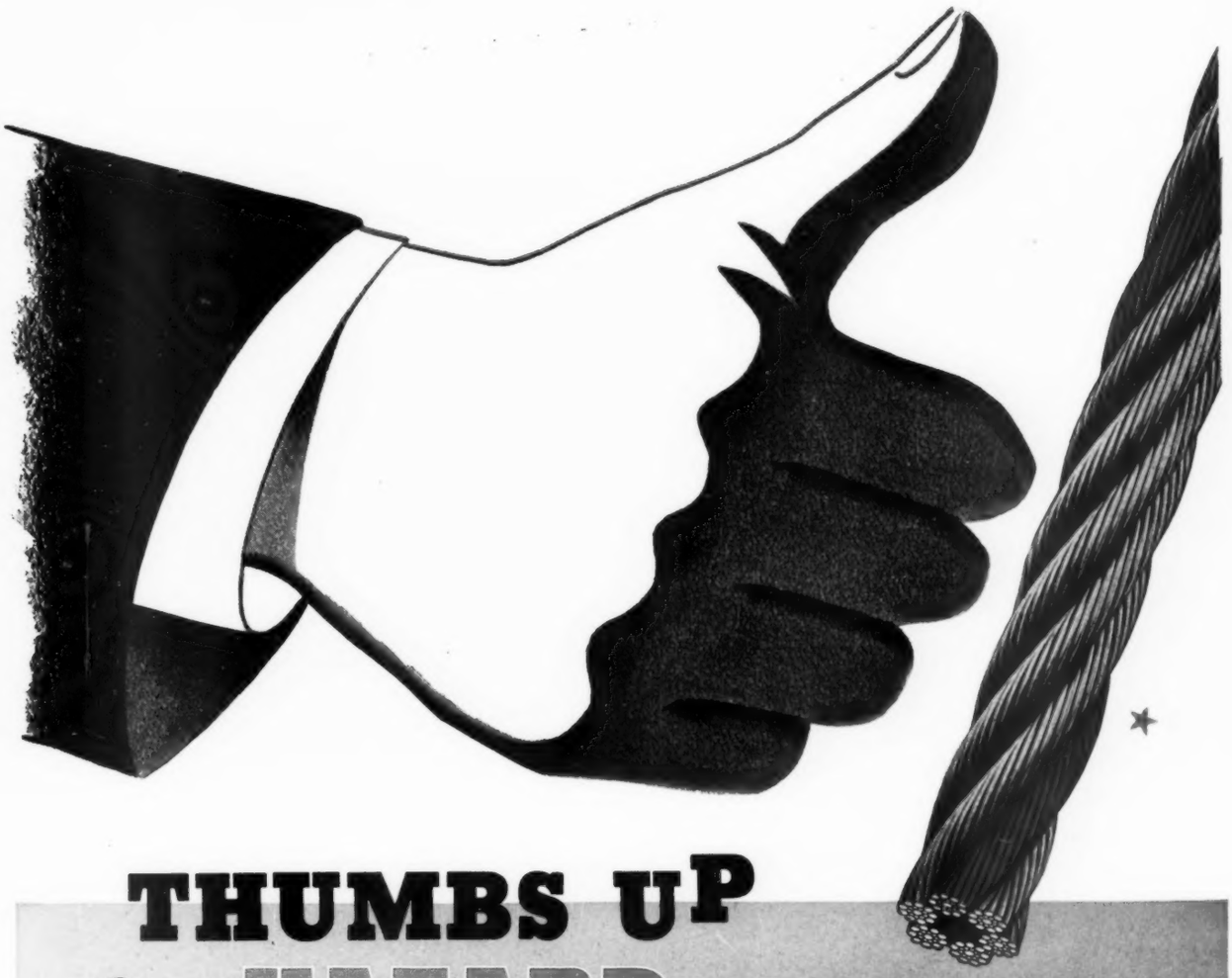

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June, 1942

THE Petroleum Engineer

VOL. XIII No. 9

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# The Course of Oil

by K. C. SCLATER

## INDUSTRY ON CALL

At the request of Petroleum Coördinator Ickes, the petroleum industry is taking an important part in the drive for scrap rubber. In making his request, Ickes said that "One of the most critical material shortages which this country must overcome to win the war is the shortage of rubber. And one principal means of meeting this shortage is through the collection and reclamation of scrap rubber throughout the Nation. There is a very large tonnage of scrap available over the country and facilities for its reclamation exist. It remains only for us to collect this scrap material.

"In keeping with the President's wish, and in collaboration with the Conservation Division of the War Production Board, which is responsible for directing the campaign as a whole, I hereby call upon the entire oil industry, from the smallest filling station to the largest company, to launch at once an all-out drive for the collection of scrap rubber for the Government. The importance of this move is so great that I do not hesitate to ask that every petroleum organization in the country assign its personnel and particularly its sales forces to the prosecution of this drive, and to employ the plant and transportation facilities of the industry in this undertaking."

The objective of the drive, which is under the immediate sponsorship of the Petroleum Industry War Council, is to try to gather every pound of reclaimable scrap rubber in homes, business and industrial establishments, and from any other place where it may be found. The industry will assist in removing rubber scrap materials wherever assistance is needed or desired.

The paramount purpose of this drive is to provide immediate factual data on the amount of reclaimable rubber in the country, and accurate and complete reports will be requested of every unit in the oil industry of the amount of scrap rubber collected, immediately after the end of the drive.

Chairman of the Petroleum Industry War Council, William R. Boyd, Jr., in answer to the President's order, said: "The oil industry has never failed you. We are organized and ready to go! Over a million men and women connected with the oil industry are ready for the take-off signal and all our facilities—our 400,000 filling stations, our automotive equipment, our cash will be put to work for the Scrap Rubber Drive.

"Every ton, every pound, every piece of reclaimable scrap rubber in America must be quickly gathered and stock-piled. We believe the total tonnage figure will be astounding, but the only way to find out is to go and get it.

"It has often been said that the oil industry in World War No. 1 floated the Allies to victory on a sea of oil. Today we are making the special fuels and lubricants to keep our airplanes flying, our ships sailing, our tanks and motor equipment rolling and we are fueling the industrial life of the nation. We know we can handle this new scrap rubber assignment also.

"Our facilities for gathering scrap rubber quickly through our far-flung nation-wide organization are ideal and unique.

"Mr. President, the petroleum industry in America accepts your assignment with enthusiasm and will not fail you and the nation."

On the results of this drive will hinge the decision on whether immediate nation-wide gasoline rationing to conserve rubber is necessary. Thus, by placing its resources at the disposal of the Government, the petroleum industry makes possible an immediate answer to a grave national problem.

## PIPE LINE APPROVED

On Thursday, June 11, the War Production Board approved the construction of a 24-inch pipe line, 550 miles long, from East Texas to the Southern Illinois area. This startling announcement is evidence of the recognition by the War Production Board of the critical need for oil transportation facilities to the Eastern Seaboard. Apparently the WPB took this action after considering the grave situation with respect to oil tankers and military requirements, and only after receiving assurance that prompt construction of the line will not interfere with delivery of steel for other vital war needs.

Investigations are being continued to determine whether steel can be made available for the remaining half of the line to the Eastern Seaboard as recommended by the Petroleum Coördinator.

An order has already been placed for the delivery of 500 miles of seamless pipe in "double-random" lengths of approximately 40 feet each. The pipe will be manufactured to A.P.I. standard line pipe Specification 5-L, grade B, and will have a wall thickness of three-eighths inch. According to this specification, the pipe will weigh 94.62 pounds per foot. At this weight, the line will require in excess of 137,000 tons of steel. There will be ten pumping stations, 55 miles apart, and the line will have a daily crude oil capacity of 250,000 to 300,000 barrels. The total estimated cost of the line will be $35,000,000 to $40,000,000.

Details of the financing, which are being worked out by the OPC in conjunction with the RFC and the industry, are not yet available.

Construction is expected to get underway in July and be completed by December first of this year.

This will be the largest-diameter oil pipe line ever constructed. Its construction may mark a new era in pipe line transportation and should yield valuable engineering data on pipe line transportation of crude oil and other petroleum products.

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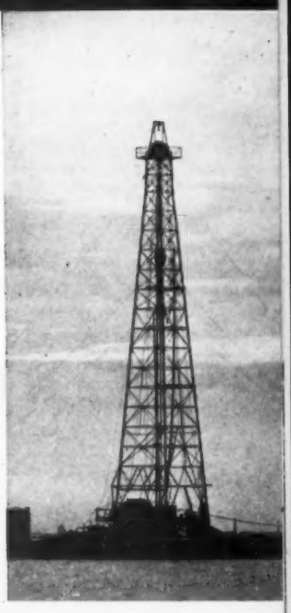

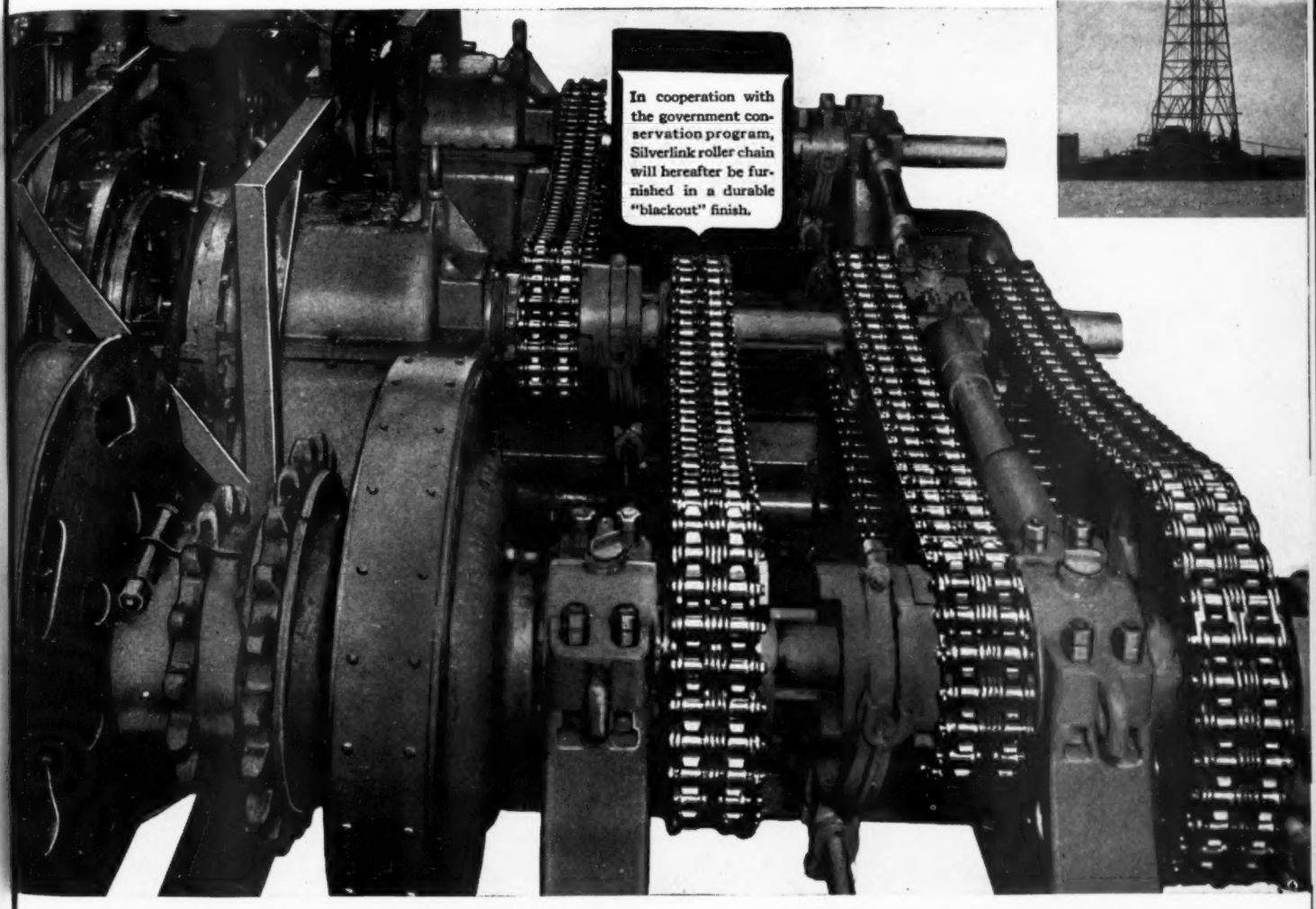
In cooperation with the government conservation program, Silverlink roller chain will hereafter be furnished in a durable "blackout" finish.

● Oil being where you find it, many of the world's better producing spots were headaches, from the standpoint of accessibility, for the men who pioneered them to the pay-off. Locations, such as the one pictured several miles from shore in the Gulf of Mexico, often give the operator poor access to his supply point. Miles of hauling via improvised swamp roads to a suitable water front . . . thence by boat to location . . . is not uncommon in getting equipment on a drilling job. Thus does the unfailing dependability of the products used at such remote points become, more than ever, a major factor. That's where Link-Belt *Silverlink* Roller Chains come in.

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# LINK-BELT *Silverlink* ROLLER CHAINS

# Highlights IN OILDOM

## Special Orders for Arkansas Sweet Gas Area

Nine large war industries in the State of Arkansas, including an aluminum plant, an ammonia plant, an acid plant, several shell loading plants, and other industries, have caused concern among officials as to the possible drain upon the state's supply of natural gas. This anxiety was entirely dispersed recently with proof that large reserves of sweet gas exist in Columbia County at shallower depth than the present large reserves of sour gas. A test in the Macedonia field has led many qualified observers to believe that the sweet gas reserves will be as great as the sour gas reserves. The sour gas reserves of southern Arkansas, according to engineers of the Oil and Gas Commission, are approximately one trillion cubic feet.

The Arkansas Oil and Gas Commission issued on June 1 a special order concerning the bringing into production of the sweet gas reserves. The largest known reserves of sweet gas exist in the Dorcheat and Macedonia fields of Columbia County. The wells in these fields are now producing sour gas and distillate from the Smackover Lime section at a depth of about 9000 ft. The sweet gas and oil reserves are found in the Cotton Valley sand at depths varying from 7000 to 8200 ft. There are some 17 productive lenses, engineers of the Oil and Gas Commission say, but no single productive horizon that extends throughout the entire field. The commission's order states that one lense from the Cotton Valley sand may be produced at a time by wells already existing in the field, the deep producing formation, or Smackover Lime, to be produced through the tubing whereas the shallow zone, or Cotton Valley, is to be produced in the annular space between the tubing and the casing. The commission further orders that wells be mechanically equipped so there would be no commingling of sweet and sour gas and that the production be maintained and measured separately.

The sour gas area is limited to one well to 80 acres by special arrangement with the Office of the Petroleum Coördinator for War. The usual gas fields in the United States are spaced one well to each 640 acres, but special dispensation was made in the case of Arkansas, where more wells are needed to supply war industries. No spacing requirements are to be issued for the Cotton Valley or sweet gas area of the fields and only production will be considered in the orders of the commission.

## Salt Water in Tinsley Wells

Producers in the Tinsley field, Yazoo County, Mississippi, announce that on June 1 approximately 136 wells not listed in the previous report showed salt water with the oil.

## Oil Industry Safety Record Continues Good

Petroleum-industry employees worked almost as safely during 1941 as they did in 1940, despite widespread national defense activities, the advent of war, numerous changes in employment, and many new employees, according to the annual report of the American Petroleum Institute's department of accident prevention.

Records of 172 companies employing 333,122 persons, who worked approximately 700,000,000 hours in 1941, indicate that the severity of injuries was unchanged from 1940, and that the frequency of injuries increased only 1.6 percent from the all-time low in 1940. Although other records are not yet available, it is believed that this safety record is substantially better than the average for all industries last year. For the last 10 years the petroleum-industry record has been less than, or close to, the all-industry average.

The index of injury frequency for all branches of the petroleum industry was 11.78, a decline of more than 60 percent since 1929. The injury severity index, 1.44, was more than 40 percent below the 1929 level. Frequency rate is the number of disabling injuries per million hours worked; severity is the number of days lost per thousand hours worked.

The composite injury index for the industry was 26.18 last year, compared with 25.99 in 1940, and 51.68 in 1929.

Indicative of the industry-wide causes of the increase in accident frequency is the fact that all branches of the petroleum industry except pipe lines showed a slight increase. Pipe-line employees recorded a marked decrease in frequency of accidents, and an even greater decline in the severity of accidents.

Lowest frequency rate, 8.45 accidents per million hours worked, was established by refinery workers. Marketing employees had the lowest severity index, 0.65 days lost per thousand hours worked.

"During these days when both employees and equipment are difficult to replace," the report states, "accident prevention becomes more important than ever before in the industrial program."

## New Regulations for Cycling Plants

The installation of various meters and the use of tanks for measuring all crude oil, condensate, or other liquid hydrocarbons to prevent waste in the operation of cycling plants have been ordered by the Texas Railroad Commission. The order is effective July 1.

Closer regulations of the amount of gas that can be vented by any plant also was included in the order. No cycling plant will be permitted to vent any gas taken into its plant from statutory gas wells, except that the commission voiced the opinion that reasonable compliance with the order will permit the venting of a volume of flash vapor not to exceed 2 percent of the volume of the gas taken into the plant.

The owner or person in charge of each cycling plant in the state shall meter separately:

(1) All gas taken into the plant from all statutory gas wells; (2) All casinghead gas taken into the plant; (3) All gas used for plant fuel; (4) All gas injected into each formation; (5) All gas taken by pipe lines or other domestic or commercial uses; (6) All gas, including flash vapors, vented directly or indirectly to the air. Gas used for lifting water by jetting or used in turbines and subsequently vented to the air or burned in a flare shall be metered accurately and reported as vented.

No gas shall be used by the plant that is not burned in boilers, heaters, or internal-combustion engines in a reasonably efficient manner, and no raw gas or residue gas shall be used for plant fuel if any flash vapors are being vented or flared.

No cycling plant shall be operated in the state without a certificate of compliance issued on a prescribed form and made a part of this order. The certificate shall be in force and effect for a period of 12 months and shall be renewed each 12 months, and shall be approved by the engineering department of the commission. This certificate, however, shall be revoked at any time an inspection reveals non-compliance with the order. Without such certificate of compliance so approved the operation of any cycling plant is prohibited, and no tenders shall be issued for the removal of any products therefrom.

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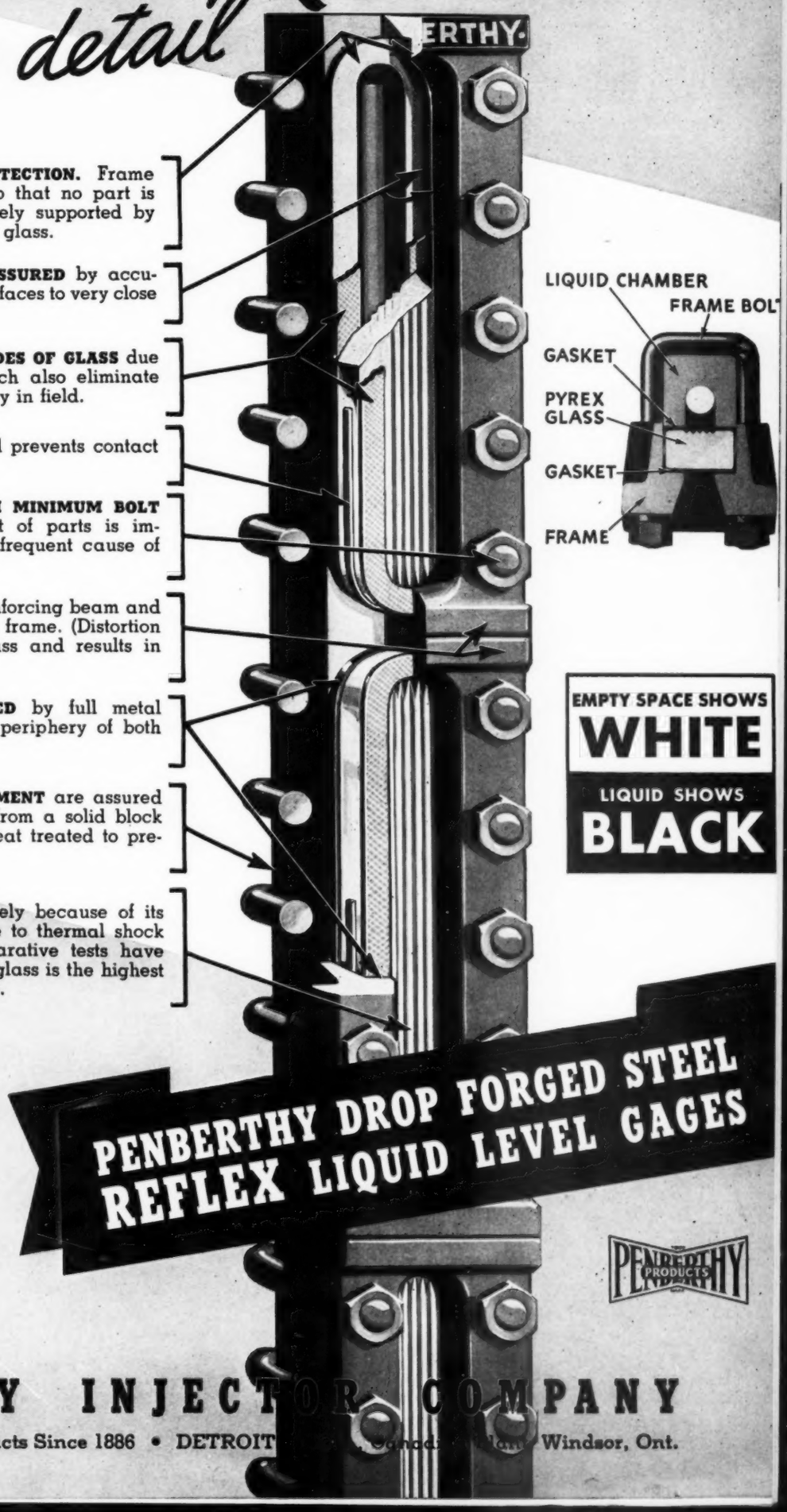


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# MAJOR *Pipe Line* ACTIVITIES

IMMEDIATE construction of a 24-in. pipe line, 550 miles in length, has been approved by the War Production Board. The line will extend from Longview, Texas, to the Salem, Illinois, area. Completion of the line is expected by December 1. Total capacity of the line is 250,000 bbl. a day either of crude oil or gasoline. Indications are that the line will be used for crude oil, although the eastern seaboard is rationing gasoline, because the fuel oil situation is threatening to become critical by winter.

Approval action of the board came after consideration of changed conditions in regard to ocean-going tankers and requirements of the armed forces and after it had been given assurance that construction will not interfere with delivery of steel or motor equipment orders for the Army, Navy, or the Maritime Commission. The line will require 125,000 tons of finished steel. Use of critical materials will be minimized by use of cast-iron pipe for steel pipe in some places and the use of seamless steel tubing instead of steel plates so badly needed in the ship-building program.

The beginning of work on the first of six projects in a comprehensive pipe-line relocation program designed to increase the flow of oil to the East Coast by approximately 200,000 bbl. a day, largely with the use of second-hand pipe, was announced recently by Petroleum Coördinator Harold L. Ickes. This program is in addition to the proposed Texas-New York pipe line.

The project, on which work has begun, will provide an all-pipeline route from East Texas and Kansas to the East Coast for movement of 25,000 bbl. of crude oil a day, mainly through existing systems.

In Texas, crews are digging up 111 miles of old 8-in. pipe line that will be used to provide additional capacity on an existing line between Dallas, Texas, and Cushing, Oklahoma. The job, it is estimated, can be completed by July 15, and will increase deliveries to Cushing, via The Texas Pipe Line Company system, by 15,000 bbl. a day.

The second section underway involves increasing the capacities of The Texas-Empire Pipe Line Company's system from Cushing, Oklahoma, to Sheldon, Missouri, and from Valley Center, Kansas, to Sheldon by a total of 30,000 bbl. a day. This will be done by installing extra pumping equipment and constructing about 32 miles of additional line, using new pipe already on hand.

According to engineering reports, construction of these two legs of the project will make possible delivery of 30,000 additional bbl. of crude oil daily into the Chicago area. Of this amount, 25,000 bbl. can be moved on eastward, mainly through existing pipe-line facilities. It will be necessary, however, to lay 150 miles of used 8-in. pipe along the Illinois Pipe Line Company's main line running eastward across Ohio from Lima, and to reverse the flow of the Tuscarora pipe line across Pennsylvania.

Five other projects, on which the Coördinator's Office has requested that action be expedited, are:

1. Increase in capacity of Plantation Pipe Line from Baton Rouge, Louisiana, to Greensboro, North Carolina, to enable delivery of 30,000 bbl. additional daily to Greensboro. This amount then would be moved northward by an extension of the Plantation line from Greensboro to a point in Virginia northwest of Norfolk. In addition to the extension job, the project will require construction of a 60,000-bbl.-per-day pipe line from near Beaumont, Texas, to Baton Rouge, to augment the supply to the Plantation line and the installation of additional pumping stations on the Plantation system. Second-hand pipe and equipment will be used.

2. Construction of a 15,000-bbl.-per-day products line from Fostoria, Ohio, connecting the Shell and Sohio gasoline pipe lines with the Sun-Susquehanna system at Akron, Ohio, for the movement of petroleum products eastward.

3. Reversal of the Keystone-Atlantic gasoline pipe line across Pennsylvania and an increase in the movement through the Socony-Vacuum pipe line from Buffalo, New York, by 10,000 bbl. a day to increase the flow through the Sun pipeline system extending southward from Syracuse.

4. Delivery of 50,000 bbl. of products a day to Helena, Arkansas, for movement by barge up the Mississippi and Ohio Rivers to Pittsburgh where it will be moved on eastward by tank car. This project will involve (a) the reconditioning, rearrangement, and conversion of a crude oil pipe line or pipe lines between Port Arthur, Texas, and El Dorado, Arkansas, into a products pipe line or pipe lines, and the reversal and extension of such pipe line or pipe lines; (b) the reversal of an 8-in. products line between Shreveport, Louisiana, and Port Arthur, Texas; (c) construction of an 8-in. line between Shreveport and Benson, Louisiana, to connect with existing facilities to El Dorado, Arkansas, and (d) the construction of a 150-mile 10-in. pipe line from El Dorado to Helena, Arkansas.

5. Delivery of 60,000 bbl. a day of refined petroleum products to a point near Paducah, Kentucky, for barging up the Ohio River to Pittsburgh by (a) the conversion and reversal of a 12-in. crude oil pipe line extending from East Texas to Houston in order to deliver 60,000 bbl. a day of refined products from the Houston refineries to a point in or near the East Texas field, and (b) the construction of a 12-in. and a 14-in. pipe line from East Texas to Paducah.

Petroleum Coördinator Ickes will again ask the War Production Board for priorities on steel to build a pipe line from Texas to New York to relieve the gasoline emergency in the East, he revealed at a recent press conference in Washington. He expects to appear personally before WPB in behalf of the project, he stated.

Donald Nelson, chief of the War Production Board, said recently the country could have the pipe line only if it wanted to sacrifice production of ships and tanks. Priorities for the project have been rejected twice, by the old supply priorities allocation board and by WPB.

The line would deliver 350,000 bbl. a day to eastern states, it has been estimated.

Consideration is being given to the laying of a pipe line from the Norman area, northwestern Canada. The pool has four producing wells with a potential production of 400 bbl. a day.

Three companies in the East have reversed the flow of their pipe lines and are thus aiding to some degree in alleviating the gasoline shortage in that area. Gasoline is being transported through lines of the Sun Oil Company from Cleveland, Ohio, to Philadelphia, Pennsylvania, the Standard Oil Company of New Jersey from Midland, Pennsylvania, to Bayonne, New Jersey, and the Atlantic Refining Company is moving crude oil through its line from Pittsburgh to Philadelphia.

Toddie Lee Wynne, president of the American Liberty Pipe Line Company, has submitted a proposal to the government for construction of a pipe line across Florida. His proposal is to salvage 200 miles of pipe and other materials from the company's line from East Texas to Houston and use them for the proposed project.

In addition to line pipe, seven stations and 700,000 bbl. of storage are available, according to Wynne.

# *Dependable power from field to refinery*

## with De La Vergne Diesel Engines

There's plenty of pipe from oil well to refinery, nearly 120,000 miles of it now. Distance has been overcome by *power*. And when you say *power*, De La Vergne Diesel Engines automatically come into the picture, for De La Vergne Diesels have been connected with oil pipe lines since 1907.

Today, more than ever before, oil pipe lines require dependable power. De La Vergne Diesels, with hundreds of time proven installations, are helping to keep the oil constantly flowing from field to refinery—to Victory.

De La Vergne Diesels are available in sizes ranging from 200 bhp to 1,500 bhp. A De La Vergne Diesel is your assurance of dependable power.

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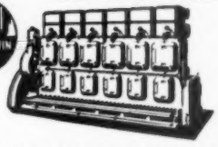
*De La Vergne*

**SALES CORP.**

BLW THE BALDWIN GROUP



SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS • PHILADELPHIA

BUILDERS OF DEPENDABLE ENGINES SINCE 1880

# MAJOR *Oil Field* ACTIVITIES

KANSAS apparently has two new oil pools in Barton and McPherson counties. Helmerich and Payne and others Merten No. 1, a Barton County test, in NW NW NE of 10-19-15w, is about four miles southeast of existing production. The well had a 2000-ft. fill of oil from the Reagan (La Motte) sand prior to running tubing and rods for a production test. Four to five bbl. of oil were swabbed from the well per hour. Production was from the sand topped at 3551 ft., and total depth of the hole is at 3578½ ft. Original show was increased by deepening and a 10-quart shot.

Dickey Oil Company's Rundberg No. 1, CW½ NW NE of 19-17-3w, is reported to be another Viola lime pool opener, one mile south of the Lindsborg pool. Ten hours after the plug had been drilled-out and the well deepened, oil rose 900 ft. in the hole. The producing lime was found at 3358 ft. with total depth at 3363 ft. Casing was set on top of the lime at 3358 ft. The hole will be jetted and acidized before completion.

A new Aux Vases sand pool appears to have been opened by The Lewis Production Company of Tulsa, Oklahoma, with the State Game Preserve No. 1 in SW SW SE, 21-3s-3e, south of Mount Vernon and east of the abandoned Marcoe pool, Illinois. Saturated Aux Vases sand was cored from 2746 ft. to 2762 ft. with the drill-stem test showing 585 ft. of oil cut mud with 5-in. casing being run. The Lewis Production Company has a lease on three 80-acre tracts.

The Jordan Drilling Company's No. 1 Munson, A. Viesca League, near the center of the old Cockfield sand area in the Livingston pool, Texas, recovered 1500 ft. of 35-gravity oil on a 14-minute drill-stem test in the Wilcox formation. Total depth of the well is 7041 ft. with the top of the sand reported at 7030 ft. Operator was coring deeper to the water table to set casing for completion.

A new pool has been found in Concordia Parish, Louisiana, by the California Company with its Pan-American Life Insurance No. 1, section 16-9s-10e, which is reported to have flowed 150 bbl. of distillate together with a large volume of gas from 9826-46 ft. Total depth of the well is 9997 ft.

Deep Rock Oil Corporation of Tulsa, Oklahoma, has opened a new pool in Noble County, Oklahoma, with Schultz No. 1, NW SW SE of 9-22-2e, west of the Marathon pool and southeast of the town of Red Rock. Drilled to 4765 ft. in the Arbuckle lime, operators backed-up and set casing at 4590 ft. and drilled-out the cement at 4552 ft. The casing was perforated with 24 shots from 4508 to 4514 ft. The well flowed clean oil after 25 minutes cleaning time. Gas flow was from 3,000,000 to 4,000,000 cu. ft. per day.

Eddy County, New Mexico, has a new pool opener in H. M. Vandagriff No. 1 by Culbertson and Irwin, Midland, Texas, and Sam Sanders, Artesia, New Mexico. The well was drilled to a total depth of 3570 ft. in limestone formation. Principal production, however, is from 3326 to 3343 ft. The hole filled 200 ft. with oil the first 12 hours. At 3527 ft. the well had 2200 ft. of oil, which after swabbing down, refilled at the rate of about 1 bbl. an hour. The well has been shutdown pending orders from the operators as to the method of completion to be used. Location of the well is in the center of the southwest quarter of the southeast quarter of section 11-19s-30e.

## AVERAGE CRUDE OIL PRICES

| | | | |
|---|---|---|---|
| California | | Louisiana | |
| Kettleman Hills | $1.23-1.29 | Rodessa | $ .88-1.20 |
| Playa Del Rey | .80- .87 | Gulf Coast | .93-1.36 |
| Coalinga | .73-1.13 | North Louisiana | .98-1.30 |
| Wilmington | .68-1.24 | | |
| Montana | 1.00-1.15 | Illinois | 1.22-1.37 |
| Wyoming | .45-1.15 | Kentucky | 1.32-1.43 |
| Colorado | 1.05-1.07 | Indiana | .85-1.25 |
| New Mexico | .70-1.15 | Ohio | |
| Texas | | Lima | 1.17 |
| North Central | .97-1.21 | Michigan | 1.24-1.44 |
| Panhandle | .70-1.12 | | |
| West Texas | .80-1.27 | Pennsylvania | |
| Gulf Coast | .93-1.48 | Bradford | 3.00 |
| Darst Creek | 1.14 | Southwest | 2.65 |
| East Texas | .80-1.27 | Eureka | 2.59 |
| Talco | .79 | Buckeye | 2.55 |
| Kansas | .93-1.25 | Corning | 1.31 |
| Oklahoma | .75-1.25 | | |
| Arkansas | .94-1.36 | | |

## DAILY AVERAGE CRUDE OIL PRODUCTION

**Data Supplied by A.P.I.**

(Figures in bbl. of 42 gal. each)

| | [1]O.P.C. Recommendations May | Week Ended May 30, 1942 | Week Ended May 2, 1942 | Week Ended May 30, 1941 |
|---|---|---|---|---|
| Oklahoma | 438,500 | [2]383,250 | 404,650 | 413,350 |
| Kansas | 259,300 | [2]256,500 | 255,300 | 208,900 |
| Nebraska | 4,500 | [2] 4,000 | 3,900 | 4,300 |
| Panhandle Texas | ..... | 98,000 | 78,500 | 77,800 |
| North Texas | ..... | 155,950 | 161,800 | 129,650 |
| West Texas | ..... | 210,000 | 140,150 | 259,100 |
| East Central Texas | ..... | 100,050 | 73,900 | 79,500 |
| East Texas | ..... | 495,000 | 146,400 | 373,700 |
| Southwest Texas | ..... | 165,950 | 114,500 | 209,850 |
| Coastal Texas | ..... | 324,850 | 181,250 | 276,650 |
| TOTAL TEXAS | 960,000 | 1,549,800 | 896,500 | 1,406,250 |
| North Louisiana | ..... | 86,550 | 81,850 | 73,200 |
| Coastal Louisiana | ..... | 208,150 | 232,500 | 252,600 |
| TOTAL LA. | 298,600 | 294,700 | 314,350 | 325,800 |
| Arkansas | 74,000 | 72,750 | 73,600 | 73,200 |
| Mississippi | 48,100 | [2] 82,000 | 91,250 | 27,500 |
| Illinois | 329,200 | 288,450 | 295,150 | 341,200 |
| Indiana | 17,900 | [2] 21,300 | 20,850 | 22,000 |
| Eastern (not incl. Ill. and Ind.) | 105,400 | 101,000 | 103,200 | 94,150 |
| Michigan | 60,500 | 64,400 | 63,200 | 38,000 |
| Wyoming | 98,300 | 93,350 | 90,750 | 85,150 |
| Montana | 25,200 | 21,700 | 21,600 | 19,050 |
| Colorado | 7,900 | 6,350 | 5,250 | 4,000 |
| New Mexico | 73,300 | 54,450 | 73,650 | 113,050 |
| TOTAL EAST OF CALIF. | 2,800,700 | 3,294,000 | 2,713,200 | 3,175,900 |
| California | 673,800 | 583,300 | 621,800 | 610,200 |
| TOTAL U. S. | 3,474,500 | 3,877,300 | 3,335,000 | 3,786,100 |

[1]O.P.C. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The U. S. Bureau of Mines reported the daily average production of natural gasoline in February, 1942, as follows: Oklahoma 29,800; Kansas 6,000; Texas 112,700; Louisiana 20,800; Arkansas 2,300; New Mexico 5,600; California 42,600; other states 21,900.

[2]Oklahoma, Kansas, Nebraska, Mississippi, and Indiana figures are for week ended 7 a. m., May 27.

# HERE'S INSURANCE

## AGAINST FLUID LOSSES IN "THIEF FORMATIONS"

## *JELFLAKE — Exclusive with Dowell —*

### *Becomes Standard in Drilling and Completion Practice*

ADOPTION OF JELFLAKE* in drilling and completion practices confirms the logic of that old "saw" about an ounce of prevention being worth a pound of cure. When used in time JELFLAKE is good insurance against costly mud or cement losses. Through its use marked savings in drilling time and elimination of equipment losses have been obtained by operators. So vital are the JELFLAKE advantages that it is being used in practically every rotary drilling area of the United States, New Zealand, Mexico, Trinidad, Cuba, Peru, Venezuela and other foreign countries.

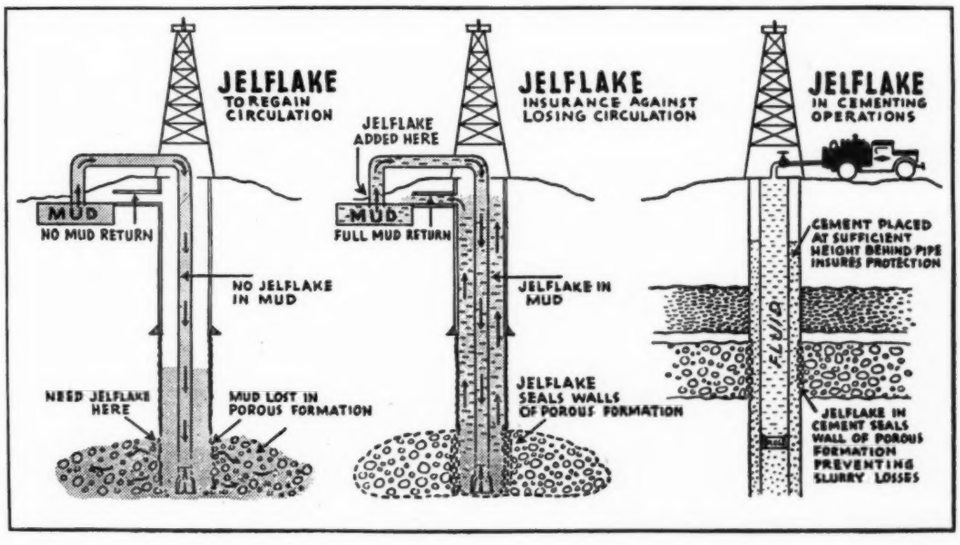
JELFLAKE is a chemically inert, thin, fragmented film substance having enormous area per unit of weight and high tensile strength. It is unaffected chemically by water, mud or high bottom hole temperatures and will not ball up, accumulate or bridge in the hole. JELFLAKE mixes easily with drilling mud or cement and stays in suspension, even when the movement of the fluid column stops. It flows evenly through drill pipe, float equipment and special cementing tools.

JELFLAKE stops the loss of drilling mud or cement slurry in "thief formations" by building up a strong, impervious wall as the fragmented film substance strains out and lodges upon the formation. This JELFLAKE wall supports high differential fluid pressures and cannot be penetrated by drilling mud or cement slurry.

JELFLAKE has proved to be more economical than other materials for restoring lost circulation. It is readily available—all Dowell treating stations and numerous oil field supply stores carry ample stocks. It is packaged in convenient form for ease in handling. Samples of JELFLAKE and special literature can be obtained from any Dowell representative, or by writing to Dowell Incorporated, Kennedy Building, Tulsa, Oklahoma.

*Trade Mark Reg. U.S. Pat. Off.

*Feeding JELFLAKE into the mechanical mixing hopper on a Dowell cementing truck.*

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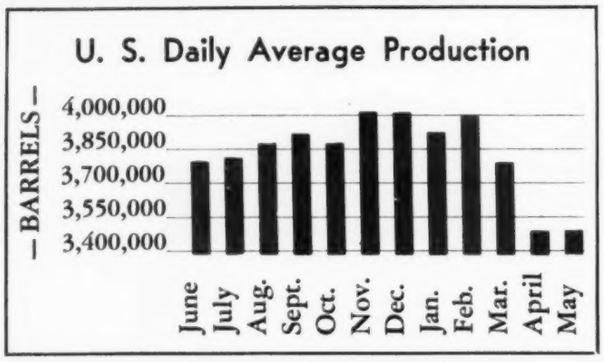
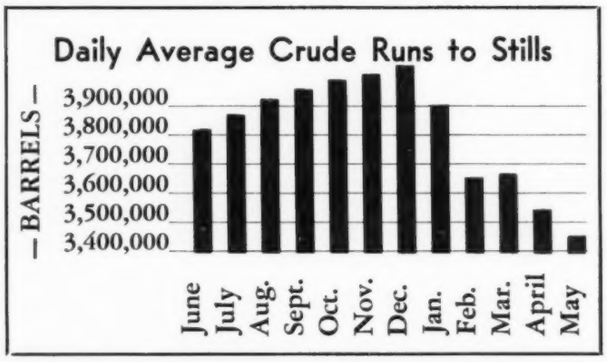
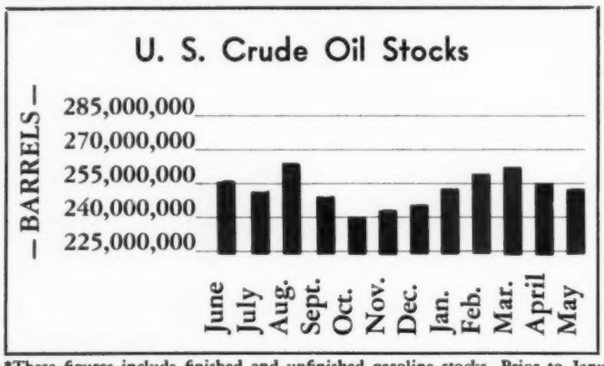
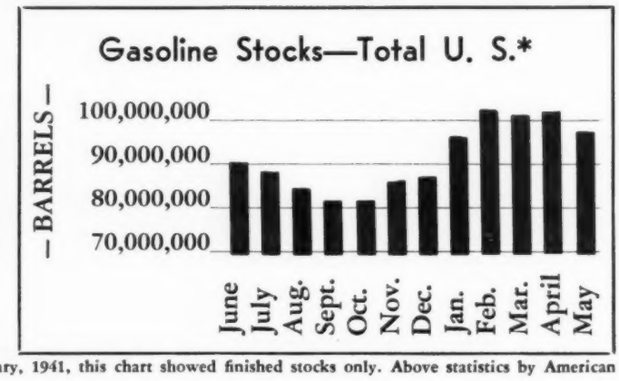
# PETROLEUM *Statistics* AND FIELD *Operations*




*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

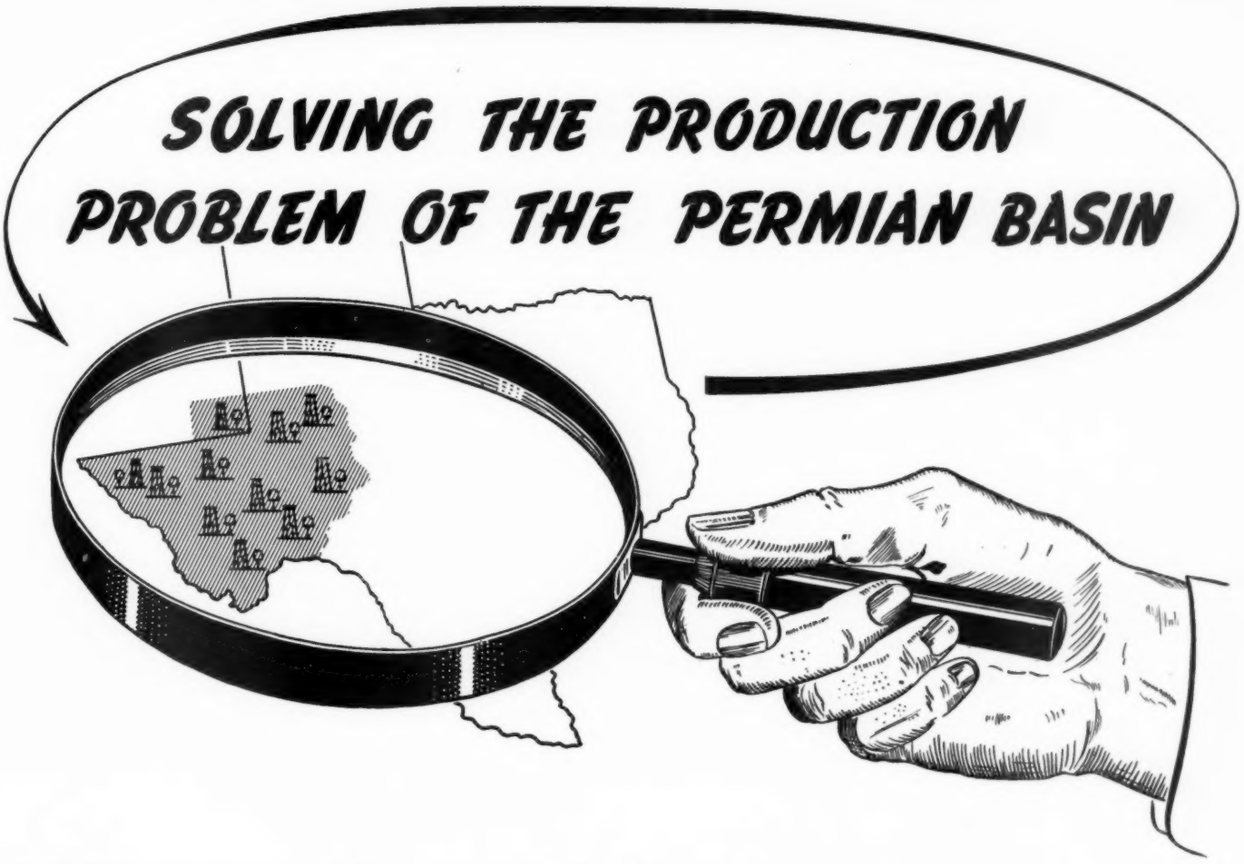
## Summarized Operations in Active Fields for May, 1942

| Fields | Completions | Producers | Rigs | Drilling Wells | Depth of Production | No. Casing Strings | Gravity of Oil | Type of Tool Used |
|---|---|---|---|---|---|---|---|---|
| TEXAS | | | | | | | | |
| East Texas | 21 | 14 | 3 | 17 | 3500-3700 | 2 | 40 | Rotary |
| Gaines County | 2 | 2 | 1 | 4 | 4400-5584 | 2 | 22-35 | Rotary |
| Hockley County | 14 | 14 | 2 | 11 | 4800-6850 | 2 | 20-30 | Rotary |
| Ector County | 7 | 7 | 3 | 9 | 3675-4377 | 2 or 3 | 32-36 | Rotary |
| Panhandle | 25 | 25 | 5 | 22 | 1700-3900 | 2 | 40 | Rot.-Cab. |
| Nueces County | 7 | 4 | 2 | 7 | 3922-5878 | 2 or 3 | 21-54 | Rotary |
| K. M. A. Field | 12 | 7 | 2 | 14 | 3730-3935 | 2 | 42-43 | Rot.-Cab. |
| Hawkins Field | 12 | 12 | 4 | 7 | 4495-4912 | 2 | 19-29 | Rotary |
| OKLAHOMA | | | | | | | | |
| Okfuskee County | 3 | 2 | 5 | 2 | 2150-4125 | 2 or 3 | 38 | Rotary |
| KANSAS | | | | | | | | |
| Russell County | 9 | 5 | 3 | 6 | 2926-3435 | 2 and 5 | 32-37 | Rot.-Cab. |
| Rice County | 15 | 11 | 8 | 5 | 3222-4085 | 2 and 5 | 42-48 | Rot.-Cab. |
| Barton County | 17 | 10 | 9 | 6 | 3290-3518 | 2 | 39-42 | Rot.-Cab. |
| ILLINOIS | | | | | | | | |
| Central Illinois | 119 | 62 | 73 | 98 | 1425-4100 | 2 | 36-38 | Rot.-Cab. |
| NEW MEXICO | | | | | | | | |
| Lea County | 8 | 7 | 3 | 5 | 3150-4030 | 2 | 30-34 | Rot.-Cab. |
| CALIFORNIA | | | | | | | | |
| Kern County | 13 | 9 | 6 | 7 | 1840-11,450 | 3 or 4 | 14-30 | Rotary |
| Wilmington | 5 | 2 | 3 | 2 | 3500-4000 | 2 and 3 | 18-20 | Rotary |

## Field Activities by States for May, 1942

| State | Completions | | Producers | | Locations | | Rigs | | Drilling Wells | | Production, 1941 (In Barrels) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | April | May | April | May | April | May | April | May | April | |
| Arkansas | 11 | 24 | 6 | 22 | 16 | 17 | 9 | 8 | 12 | 8 | 29,263,000 |
| California | 37 | 72 | 28 | 64 | 47 | 49 | 42 | 37 | 23 | 18 | 230,271,000 |
| Colorado | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1,792,000 |
| Illinois | 123 | 125 | 65 | 93 | 81 | 66 | 76 | 96 | 85 | 107 | 131,272,000 |
| Indiana | 41 | 47 | 17 | 32 | 33 | 30 | 6 | 10 | 15 | 19 | 6,998,000 |
| Kansas | 138 | 88 | 87 | 70 | 74 | 75 | 4 | 14 | 34 | 94 | 82,733,000 |
| Kentucky | 11 | .... | 4 | .... | 2 | .... | .... | .... | .... | .... | 4,790,000 |
| Louisiana | 82 | 101 | 61 | 86 | 42 | 39 | 9 | 25 | 13 | 37 | 116,038,000 |
| Michigan | 52 | 41 | 31 | 33 | 40 | 41 | 11 | 15 | 20 | 28 | 16,312,000 |
| Mississippi | 5 | 22 | 0 | 16 | 1 | .... | .... | .... | .... | .... | 15,528,000 |
| Montana | 17 | 15 | 15 | 12 | 4 | 0 | 1 | 4 | .... | 10 | 7,440,000 |
| Nebraska | 7 | .... | 2 | .... | .... | .... | .... | .... | .... | .... | 1,785,000 |
| New Mexico | 41 | 54 | 32 | 48 | 18 | 21 | .... | 9 | .... | 13 | 39,109,000 |
| New York | 75* | 96* | 75* | 94* | 22 | .... | .... | .... | .... | .... | 5,180,000 |
| Ohio | 59 | 71 | 36 | 68 | 18 | .... | .... | .... | .... | .... | 3,342,000 |
| Oklahoma | 100 | 130 | 59 | 118 | 90 | 92 | 16 | 21 | 71 | 76 | 154,817,000 |
| Pennsylvania | 169* | 264* | 164* | 240* | 28 | .... | .... | .... | .... | .... | 16,700,000 |
| Texas | 369 | 762 | 257 | 514 | 506 | 636 | 398 | 463 | 371 | 443 | 501,745,000 |
| West Virginia | 51 | 67 | 44 | 53 | 35 | 37 | 12 | 20 | 21 | 29 | 3,418,000 |
| Wyoming | 3 | 9 | 3 | 5 | 3 | 5 | 4 | 4 | 3 | 3 | 29,952,000 |
| Total | 1391 | 1988 | 986 | 1568 | 1060 | 2676 | 588 | 726 | 668 | 885 | 1,398,485,000 |

*Includes water-intake and pressure wells.




# Nixon Gas-Lift System

Look at the records of a number of leases in the Permian Basin that are producing with the Nixon Gas-Lift System.

Several hundred installations in this West Texas-New Mexico area are handling the heavy volumes of sand, formation gas, and low fluid levels with extreme economy and efficiency.

Operating costs are being held to an extreme low, so that despite low allowables and small returns, operators are able to show a profit.

| Lease A | Lease B | Lease C | Lease D |
|---|---|---|---|
| Number of Wells equipped with Nixon Gas-Lift . . . . 42 | Number of Wells equipped with Nixon Gas-Lift . . . . 29 | Number of Wells equipped with Nixon Gas-Lift . . . . 37 | Number of Wells equipped with Nixon Gas-Lift . . . . 16 |
| Average months of operation per well . . . . 17.9 months | Average months of operation per well . . . . 10.5 months | Average months of operation per well . . . . 11.2 months | Average months of operation per well . . . . . 13 months |
| Average cost of repair parts per well per day . . . $.048 | Average cost of repair parts per well per day . . $.0026 | Average cost of repair parts per well per day . . $.0058 | Average cost of repair parts per well per day . . . $.022 |

## WILSON SUPPLY COMPANY

**1412 MAURY STREET** — **HOUSTON, TEXAS**

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# MAJOR *Refining* ACTIVITIES

## Percent Refining Capacity Operated

**Western Division, 71.7 Percent  Central Division, 92.6 Percent  Eastern Division, 63.7 Percent**

THE Standard Oil Company of New Jersey has placed in operation the first of the new fluid catalyst refining units, which will increase the production of 100-octane gasoline and provide material used in the manufacture of synthetic rubber. During the first ten days of operation the new unit exceeded the anticipated output by 20 percent, officials of the company stated.

More than 30 similar plants are being constructed throughout the country by various companies, it is announced.

◆

John A. Brown, president of Socony-Vacuum Oil Company, Inc., at the recent annual meeting of stockholders of the company, reported that construction is underway on eight refineries to approximately double production of aviation gasoline. The program is expected to cost about $27,400,000. Of this sum the company is supplying $13,400,000 and the government is supplying the rest. Brown also reported that the company was building a plant in Texas at government cost to extract toluene from petroleum to make explosives. According to Brown, company engineers have developed a catalytic cracking process "Thermofor," which it is believed will save considerable material and cost for plant construction. A 20,000-bbl. a day unit is being constructed at one refinery that will be in operation within a year. Two other units have been authorized, Brown added. The company is one of five that formed the Neches Butane Corporation to make 10,000 tons of synthetic rubber per year.

◆

Humble Oil and Refining Company recently closed contracts with the government for the construction of two plants, one to manufacture synthetic rubber and the other to make a basic ingredient. The total investment will be approximately $43,000,000.

The plants will be near Houston, Texas. The government will build the plants at a cost of about $16,000,000 each and lease them to Humble for operation. The remainder of the $43,000,000 investment will be made by Humble in its refinery to produce raw materials to be supplied by it in connection with the manufacture of butyl rubber and butadiene.

Upon completion of the butyl rubber plant the government will lease it to Humble for operation under contract with Reserve Rubber Company, a subsidiary of the Reconstruction Finance Corporation, to supply large quantities of rubber. The other plant will produce butadiene, a basic ingredient of synthetic rubber.

One of the largest cycling plants in South Louisiana is scheduled to be constructed in the Erath field, Vermilion Parish. Priorities already have been granted and work is expected to get underway immediately, reports say.

Companies interested in the project are Humble Oil and Refining Company, The Texas Company, Phillips Petroleum Company, and Tide Water Associated Oil Company.

◆

The Associated Refineries, Inc., has been formed by eight independent refiners of Oklahoma and North Texas, for the purpose of constructing a $10,000,000 refinery at a point in southern Oklahoma.

The plan has been approved by the War Production Board and the Defense Plant Corporation, its agent, has been given priorities to obtain essential material for the plant, which will manufacture 100-octane gasoline and other defense materials.

M. Lloyd Freese, vice-president of the Bell Oil and Gas Company, Tulsa, Oklahoma, is president of the new organization. Freese announces his associates will be L. B. Simmons, president of Rock Island Refining Company, Duncan, Oklahoma, as chairman of the board; Roy B. Jones, president, Panhandle Refining Company, Wichita Falls, Texas, as vice-president; R. B. Anderson, of W. T. Waggoner Estate, Vernon, Texas, as vice-president; B. I. Lubell, of the Bell Oil and Gas Company, as vice-president; H. B. Alspaugh, Rock Island Refining Company, secretary-treasurer, and assistant secretaries will include I. A. Anson, Ben Franklin Refining Company, Tulsa, and C. D. Lund, Rock Island Refining Company. General offices of the company will be in Tulsa with branches in Duncan, Wichita Falls, and possibly Vernon.

The new plant will be one of the largest government supported projects in the Southwest. Processing equipment manufactured by the Universal Oil Products Company will be installed, it is announced, and construction of the plant will be by Frick-Reid Supply Corporation on a turnkey basis.

The capacity of the plant will be 30,000 bbl. of crude oil a day.

Refiners who are stockholders in Associated Refineries, Inc., are Anderson-Prichard Oil Corporation, Cyril and Oklahoma City, Oklahoma; Ben Franklin Refining Company, Ardmore and Tulsa, Oklahoma; Bell Oil and Gas Company, Tulsa and Grandfield, Oklahoma; Cosco Refining Company, Wynnewood, Oklahoma; LaSalle Petroleum Company, Burkburnett, Texas; Panhandle Refining Company, Wichita Falls; Rock Island Refining Company, Duncan, and W. T. Waggoner Estate, Vernon.

**Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks**
**Week Ended May 30, 1942**
**A.P.I. Figures**
**(Figures in thousands of bbl. of 42 gal. each)**

| DISTRICT | Percent Potential Capacity Reporting | Daily Avg. Crude Runs to Stills | Percent Operated of Total Capacity Reporting | Total Motor Fuel Stocks | Total Gas and Fuel Oil Stocks |
|---|---|---|---|---|---|
| *Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas | 89.7 | 1,519 | 63.7 | 44,020 | 31,906 |
| Appalachian | 84.5 | 159 | 91.4 | 3,422 | 1,066 |
| Ind., Ill., Ky. | 84.9 | 778 | 99.2 | 19,294 | 5,850 |
| Okla., Kans., Mo. | 81.1 | 360 | 86.1 | 8,893 | 2,684 |
| Rocky Mountain | 50.7 | 90 | 65.2 | 2,530 | 897 |
| California | 90.9 | 616 | 78.3 | 17,196 | 68,609 |
| TOTAL U. S.—B. OF M. BASIS MAY 30, 1942 | 86.9 | 3,522 | 75.2 | (a)95,355 | 111,012 |
| TOTAL U. S.—B. OF M. BASIS MAY 23, 1942 | 86.9 | 3,393 | 72.4 | 97,034 | 110,056 |
| U. S. B. OF M. BASIS MAY 31, 1941 | | 3,759 | | 93,156 | 126,743 |

(a) Finished, 88,042,000 bbl.; unfinished, 7,313,000 bbl.
* At the request of the Office of the Petroleum Coordinator.

THE Petroleum Engineer

JUNE, 1942

# Latest Type Piling Structure For Gulf Coast Marine Drilling

☆ **Designed for uniform load distribution by employing improved method of bracing and scabbing piling**

*by C. C. Pryor*

Assistant Editor

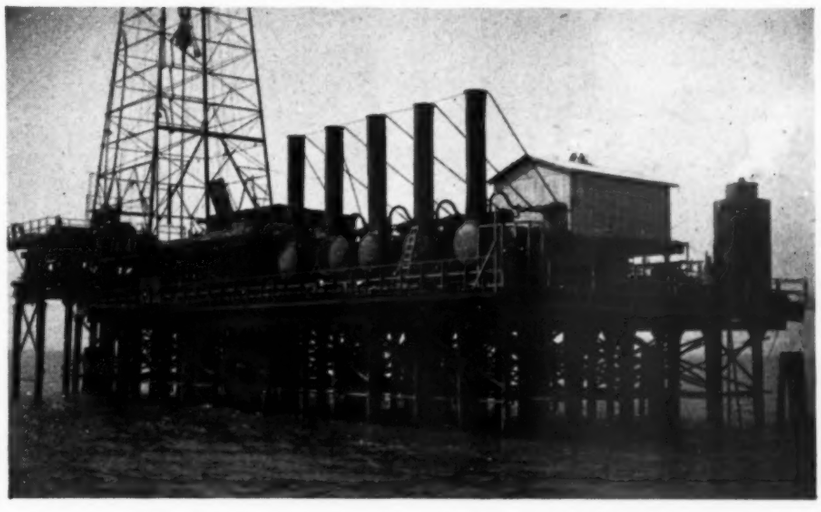
DESIGN and construction of piling structures for drilling in open water along the coast of Louisiana and Texas in the Gulf of Mexico has benefited greatly from the cumulative experience of engineers engaged in this phase of marine drilling (Fig. 1).

Among the many serious obstacles to be overcome before a piling structure is ready for drilling operations is that of the formation into which the piling is driven, which may allow the structure to settle. At many locations soil formation tests are made at piling structure locations. For a typical example, see Table 1.

## Piling

One important practice adopted by engineers in construction of the structure is the method of scabbing used on each pile. Details of piling scabbing are shown in Fig. 2. In this instance, four 6-in. by 8-in. by 8-ft. scabbing were used on each pile. Two 1-in. by 24-in. machine bolts spaced 5 ft. apart were used to bolt the scabbing to the piling. The upper ends of the scabbing were tapered in an effort to facilitate removal of the piling after the well or wells had been completed. The lower ends were placed at varying distances from the end of the piling depending on the depth to which the individual piling was to be driven. The bottom ends of the scabbing were driven into the most solid formation as a distinct aid in preventing settling of the structure. At some locations the formations through which the piling must be driven is so compacted that it is necessary to jet the piling to remove them. Removal of the piling other than that necessary around the wellhead after completion is in compliance with government regulations.

*Fig. 1. General view of the piling structure from the boiler side. The mud house may be seen across from the boilers on the upper deck*



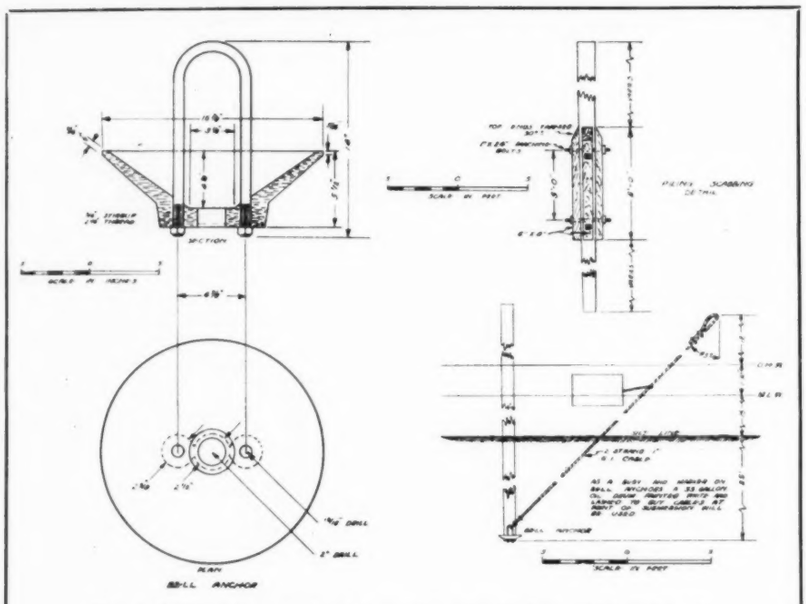


*Fig. 2. Bell anchor for derrick guy lines and pile scabbing details*

## Results of Scabbing

During the driving of the 65-ft. pile with a penetration of 35 ft., it had a bearing of 8,000 to 10,000 lb. With the scabs in the hard clay the bearing ranged from 35,000 to 40,000 lb. During the drilling operations it was estimated that the piling had a bearing of 50,000 lb. plus. The individual legs of previous structures were found to settle when driven without the scabbing.

## Capping and Beams

Scabbing has been found to play a major role in preventing settling of the structure; however, another important practice adopted by engineers is the capping and bracing of piling. The top of the piling on the installation being discussed was 15 ft. above the mean low water level (Fig. 3). The cap for each pile was made from ⅜-in. steel plate. (See Fig. 4.) Width of the plate depended on the size of the piling. For 12-in. butt piling each cap was 23 in. in length on top of the piling and 12 in. wide. The sections bent down and bolted to the piling were 16 in. in length tapering to an 8-in. width. These flaps were bolted to each pile by two 1-in. bolts through 1⅛-in. holes. The first hole was drilled 6 in. below the top of the piling and the second 12 in., allowing 4 in. space to the end of the flap. Through the top of the plate two ⅞-in. holes were drilled at each end and 16-in. steel I-beams weighing 45 lb. per linear ft. bolted across the tops of the piling with ¾-in. bolts (Fig. 5). This longitudinal method of laying the beams insured maximum load distribution over the entire structure and was of great importance in preventing settling of individual pile or sections of the structure. Machinery and equipment weighing approximately 300,000 lb. at one location were unloaded on one section of the structure, which caused settling due to another method of bracing being employed. Equipment of about the same weight was unloaded on this structure without any settling occurring.

## Bracing

The bottom bracing around the structure was of 4-in. by 4-in. by ⅜-in. angle-iron as were the cross braces shown in Fig. 5. After the longitudinal I-beams were bolted in position, 14-in., 34-lb. steel I-beams were used as cross beams. A third section of 6-in., 15.5-lb. steel I-beams with 2 by 4 nail strips was then laid across the 14-in. beams after which 3 by 12 decking was installed. The entire structure,

**Table 1**

TEST HOLE No. 1

| | |
|---|---|
| 0- 6 ft. | Silt |
| 6- 8 ft. | Sandy clay |
| 8-12 ft. | Free coarse grey sand |
| 12-13 ft. | Silty fine sand |
| 13-14 ft. | Sandy clay (hard) |
| 14-17 ft. | Sand with nodules of clay |
| 17-20 ft. | Soft, silty, clay, some shells |
| 20-25 ft. | Hard clay |
| 25-31 ft. | Sandy, silty, clay and shells |

TEST HOLE No. 2

| | |
|---|---|
| 0- 5 ft. | Silt |
| 5- 8 ft. | Sandy clay (hard) |
| 8-10 ft. | Sand—little silty clay |
| 10-12 ft. | Free coarse sand |
| 12-14 ft. | Sand and clay nodules |
| 14-17 ft. | Brown water sand—small clay nodules |
| 17-20 ft. | Soft, silty clay and shells |
| 20-25 ft. | Hard clay |
| 25-30 ft. | Sandy silt, clay, and shells |

*Fig. 3. Photo shows the bracing, capping, and loading of piling. Note dolphins of five piles wrapped with cable*

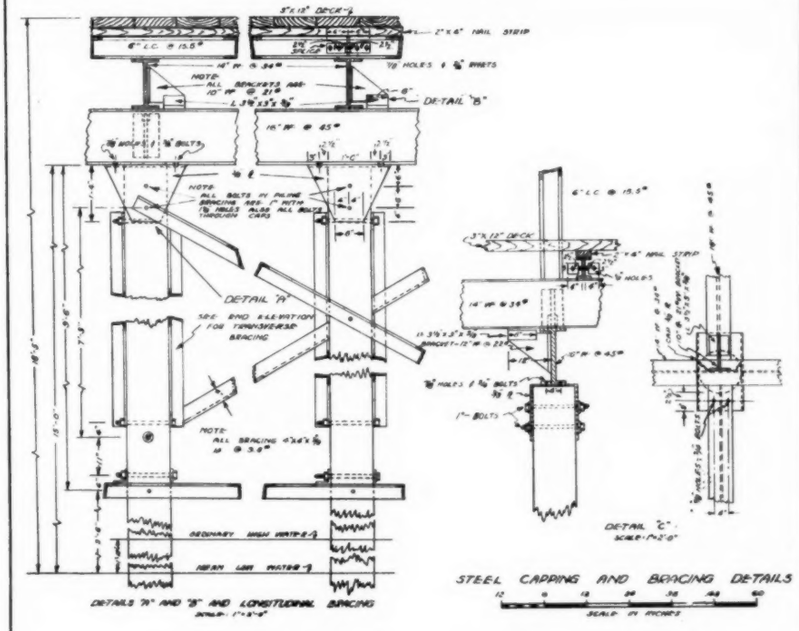



*Fig. 5. Details of piling bracing, capping, I-beam loading, etc.*

except for the piling and flooring, was of steel.

### Equipment Section

Such equipment as the mud-mixing tank, mud suction tanks of 500-bbl. capacity, mud pumps, boilers, reserve mud tank, fuel tank of 500-bbl. capacity, and 500-bbl. capacity water tank was situated on the lower deck.

The equipment section of the structure (Fig. 6) exclusive of the derrick

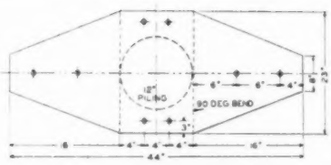


*Fig. 4. Sketch of cap for 12-in. pile*

section, required thirty-one 65-ft., 16-in. butt, 12-lb. creosoted piling and forty-four 65-ft., 14-in. butt, 12-lb. creosoted piling. This structure was 115 ft. in length and 58 ft. wide. The lower deck of this section was 15 ft. ⅜ in. above the mean low water level. The upper deck of this section is indicated in Fig. 4 and is 13 ft. 9 in. above the lower deck.

### Derrick Section

For the derrick section twenty 80-ft., 20-in. butt, 12-lb. creosoted piling and eight 75-ft., 17-in. butt, 12-lb. creosoted piling were used. Fig. 6, Fig. 7, and Fig. 8 are detailed drawings of this section. The derrick floor was 33 ft. 3⅜ in. above mean low water level. The piling beneath the derrick were also steel capped as was the equipment section with the exception that larger and longer piling were used. The heavy I-beams used across these piling were 36-in. and weighed 230 lb. Cross bracing was the same as that used on the equipment section. The derrick section of the structure was 30 ft. square. Two sections added on each side of the derrick were for the "California" type drawworks. As these sections were connected to the derrick section only two 75-ft., 17-in. butt, 12-lb. creosoted piling were used to support the auxiliary drawworks and engine. The main drawworks and engine were installed on four 75-ft., 17-in. butt, 12-lb. creosoted piling. The guy lines of the 136-ft., 800,000-lb. capacity derrick were anchored with bell anchors, details of which are shown in Fig. 1. Dolphins around the structure are of 5 piling each 60 ft. in length with 13-in. butts. Ten turns of 1-in. cable hold the five piling in a compact group.

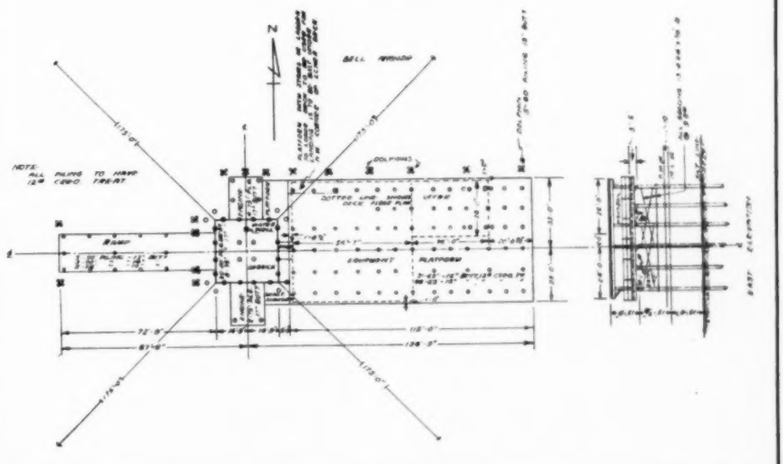
### Equipment Location

As previously mentioned, the lower deck is used for the heavier equipment such as boilers, mud tanks, etc. The upper deck is used for the pipe rack and mud house. Two shale shakers are situated on the derrick structure between the equipment section and derrick section of the structure. Ample space between the lower and upper decks on the derrick section permits easy accessibility to the blowout preventer and other wellhead equipment. The boilers are mounted on the corner at the opposite end of the structure from the derrick and the mud house is across the structure from the boilers.

### Economical Features

One of the most economical features of the piling structure is the ease with which more than one well can be drilled. On a similar structure, 10 wells were directionally drilled for production besides a water well to supply the needs of the rig. In addition to the drilling of several wells the ease

*Fig. 6. Piling plan showing location of all piling, dolphins, upper and lower deck, and east elevation*



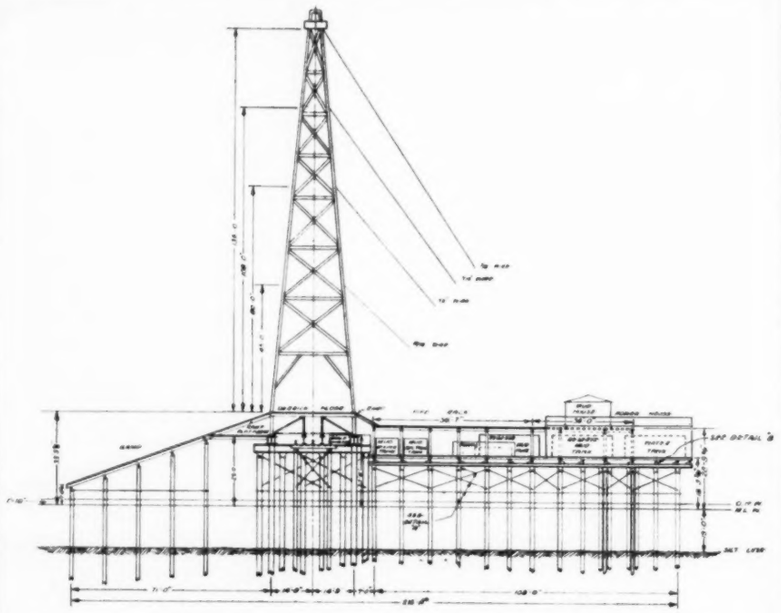
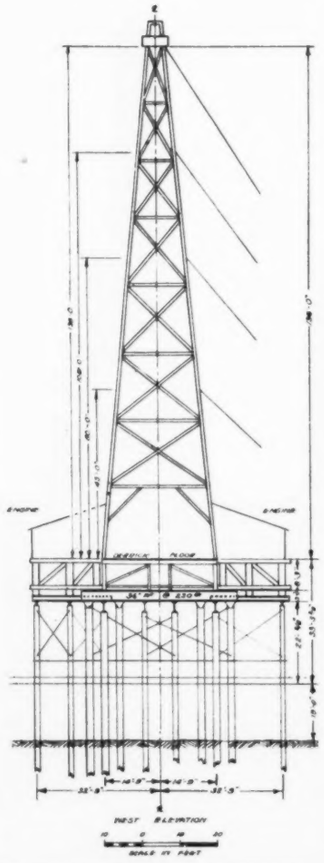


*Fig. 8. South elevation of structure showing location of equipment such as shale shakers, mud and water tanks, and pumps*

*Fig. 7. West elevation showing derrick piling and engine locations*



with which the entire structure is salvaged adds much to its economy. Obviously, the entire amount of steel I-beams used in the construction can be removed even more quickly than they were constructed. The piling need not be broken off but may be pulled or jetted out.

## Principal Equipment

The battery of five boilers mounted on the structure are of 125 hp. and 350-lb. working pressure. A feedwater tank of 90-bbl. capacity and having a chemical treating attachment is also mounted on the structure. An all-steel high-speed 27½-in. rotary table fully-enclosed is used with enclosed twin drilling engines, one 14 by 14 and the other 12 by 12 as a standby unit. The regular drawworks equipment (Fig. 9) is a fully-enclosed type with the standby drawworks fitted with a sand reel upper drum attachment. One 14 by 7½ by 14 and two 15 by 8½ by 20 slush pumps were employed.

## Utility

A piling structure for drilling possesses wide flexibility of operation for marine drilling in that it may be used with great safety in water too deep for drilling barges, which are sunk on bottom at the location. Drilling barges are usually built for depths of from 5 to 10 ft. The combination barge and piling structure for drilling operations require the maintenance of barges for power equipment, such as boilers, generators, pumps, mud tanks, water tanks, fuel tanks, etc. Rough water may render the use of this type arrangement extremely difficult at times.

Properly designed and constructed, a piling structure has a majority of the economical features so essential to modern-day drilling practices.

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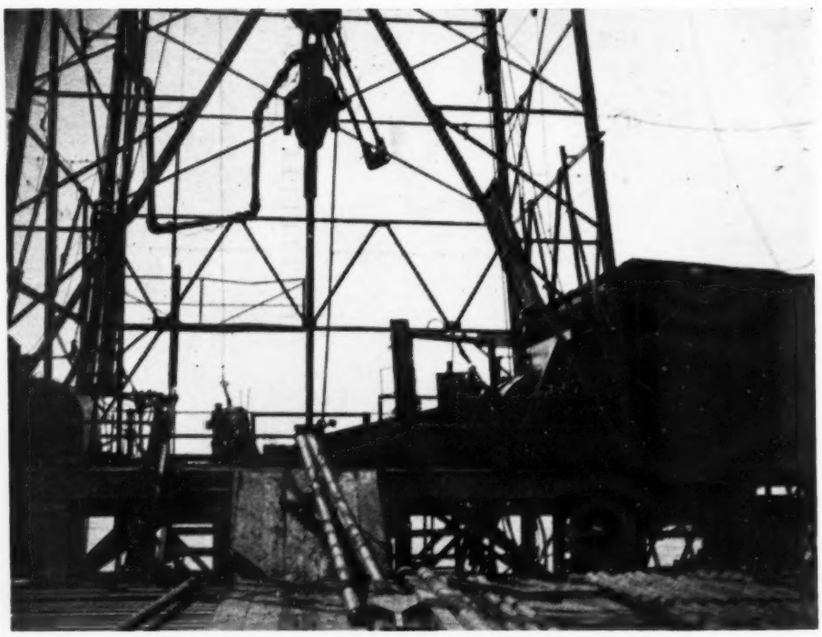
*Fig. 9. Derrick floor taken from pipe rack. "California" type drawworks may be seen on each side of derrick. Note enclosed rotary and main drawworks*



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# Safety in the Refinery

**With refineries playing such an important role in the war effort, now more than ever before is the observance of safe practices essential**

*by David V. Stroop*

Director, Department of Accident Prevention, American Petroleum Institute

TOLUENE and glycerin for explosives, super motor fuels and lubricants for war planes, raw materials for synthetic rubber, and all the normal petroleum products for fueling and lubricating the vehicles and weapons of war and the industrial plants behind the guns, make the safe operation of petroleum refineries of supreme importance at this time.

The 100,000 men who man America's petroleum refineries, as well as the hundreds of thousands of other workers who supply them with raw materials and distribute the finished products, must work safely. The records show that, despite the fundamental dangers peculiar to the handling of flammable materials at extremes of temperature and pressure, the petroleum refinery is a safer place to work than the average industry, and that refinery employees are nearly twice as safe on the job as off.

There is every indication that the years of intensive training in accident and fire prevention throughout the country's refineries will bear fruit in an enviable safety record despite the expanded tempo of operations and added dangers during the war. Already, though there was a slight increase in the severity and frequency of refinery accidents in 1941, it is believed that this rise was far less than the increase for industry generally.

So thorough has been the training of refinery employees during the last 15 years that probably a majority of all workers has been schooled in accident and fire prevention, in fire fighting, and in first aid. Safety instruction is a continuous, vital part of the everyday work at almost all refineries.

War has brought not only a need for more-intensive accident and fire prevention because of heightened activity at refineries, but also a necessity for protection against possible enemy attempts to put refineries out of operation by sabotage and bombing.

**DAVID V. STROOP**

in addition to being director of the A.P.I.'s department of accident prevention, is director of its department of engineering, secretary of its division of marketing, chairman or secretary of several of its standing committees, and official representative of the Institute on committees of the National Safety Council, the National Fire Protection Association, and others—Recently he added still another big job, that of secretary of the Petroleum Industry War Council's Committee on Protection of Petroleum Facilities—He was graduated by George Washington University with the degree of B.D. in engineering; three years ago he received an L.L.B. after night work at New York Law School—From 1910 to 1919 he was surveyor and junior engineer in the Office of Public Buildings and Grounds at Washington, and from 1919 to 1921 was assistant district engineer of the U. S. Forest Service at Portland, Oregon—He was appointed district manager of The Barrett Company at Washington in 1921, leaving in 1922 to become superintendent for the Charles H. Tompkins Company, also at Washington—In 1924 he was made associate engineer of the National Bureau of Standards, which he left in 1928 to join the staff of the A.P.I.

These added dangers have been met with increased protective measures, including the training of more workers, the manning of additional fire brigades, and the establishment of additional first aid stations. In an emergency practically every man in a refinery will have a job to do.

The problems brought on by the war were understood with little difficulty by refinery workers. Years of training in the protection of their plants against normal dangers engendered a spirit of loyalty that made the war problems their own problems. Some protective measures probably are not yet in operation in some refineries, but the fundamental problem of obtaining employee awareness and coöperation was easily solved.

## Hazards Many

A review of the safety movement in the petroleum industry is inspiring. Not only is the industry subject to all the hazards common to most industries in the handling of power equipment and heavy construction work, but it also is beset by nature with the invisible dangers of working with vapors and gases that are both flammable and lethal. Yet the industry's safety record has improved so greatly that for more than 10 years it has been below, or close to, the average for all industries.

This was not always true. Since 1927 the freguency of injuries has declined 63 percent, and their severity has declined 46 percent. The 1941 record, just compiled, reveals that the severity index for the entire industry remained at the low 1940 level, but that the frequency of injuries increased slightly, undoubtedly due to expanded operations throughout the industry. The severity index rose by a few percentage points in every branch of the industry except pipe lines.

In petroleum refining the frequency index, indicating the number of disabling injuries per million man hours worked, rose from 8.25 to 8.45, and the severity index, recording the number of days lost per 1000 man hours worked, rose from 1.34 to 1.82. These 1941 figures, however, are still only 40 percent of the frequency and 70 percent of the severity indexes in 1929. The frequency of refinery injuries is

much lower than in any other branch of the petroleum industry, although their severity is somewhat above the average.

Chiefly responsible for this inspiring record have been the close coöperation between oil-company chief executives, their safety engineers, and the workers; the first-aid training of the U. S. Bureau of Mines; the editorial assistance of the petroleum trade press, and the work of the petroleum section of the National Safety Council and of the department of accident prevention of the American Petroleum Institute.

## Employee Training

Chief executives of oil companies are actively interested in accident prevention and strong safety programs, directed by skilled safety engineers, are a regular part of the operating program of practically every refinery.

Employee training is carried on regularly by various methods. In addition to first-aid classes and instruction in fire fighting, foremen hold regular safety meetings at which accidents are discussed and unsafe conditions reported. A recent development in some plants has been the conference-type meetings, in which groups of employees study particular safety problems. Opinions, thoughts, and experiences of each member are shared, and usually agreement is reached on the safest and most logical method of doing the job. Complete understanding and information on "how and why," transmitted in this or some other manner, have done much to eliminate indifference among workers.

The petroleum section of the National Safety Council, formed in 1921, has grown to be one of its strongest divisions. Oil-company safety supervisors are quite prominent as speakers before general sessions, and are active in other sections, such as the motor vehicle and plant publications sections.

The safety movement in the petroleum industry received its greatest impetus in 1927, however, with the recognition of its importance as a major problem by the American Petroleum Institute. First handled by an appropriation to the National Safety Council, the Institute's safety work in 1931 became a full-time activity with the creation of a department of accident prevention.

## Institute's Work

Technical studies and special problems are a function of the Institute's central committee on accident prevention, which meets regularly to discuss the special problems within the industry. The department compiles the annual accident statistics for the industry, and publishes monthly bulletins of accident-prevention information. Institute committees conduct studies of operating problems, and have published 11 accident-prevention manuals of which thousands of copies have been distributed to industry executives and workers.

Standardization of practices and equipment, sponsored by Institute committees, have been important in the prevention of accidents through failure or lack of care of equipment. In refining, the A.P.I.-A.S.M.E. code on unfired pressure vessels for petroleum liquids and gases serves as an operators' and inspectors' guide to keep pressure equipment in a safe condition. A manual of inspection procedures covering other refinery operations is now being prepared by a committee. The failure of a still, in which lives are lost, has become quite unusual.

Safety programs, besides their primary importance in saving lives and eliminating human pain and anguish, are good business. Recently it was calculated that if the injury frequency of 1927 had continued through 1940, petroleum-industry workers would have suffered some 122,536 more disabling injuries than they did. If the estimate of insurance men that each disabling injury costs about $300 is correct, accident prevention thus saved about $36,760,800.

Petroleum refineries are safe places to work. Intelligent management and trained workers, sharing the knowledge and experience of the entire industry, have made the hours at work twice as safe for the average employee as are his hours of leisure, and whatever the emergencies brought by war, the army of refinery workers is highly trained to fight them — to keep essential war products moving.

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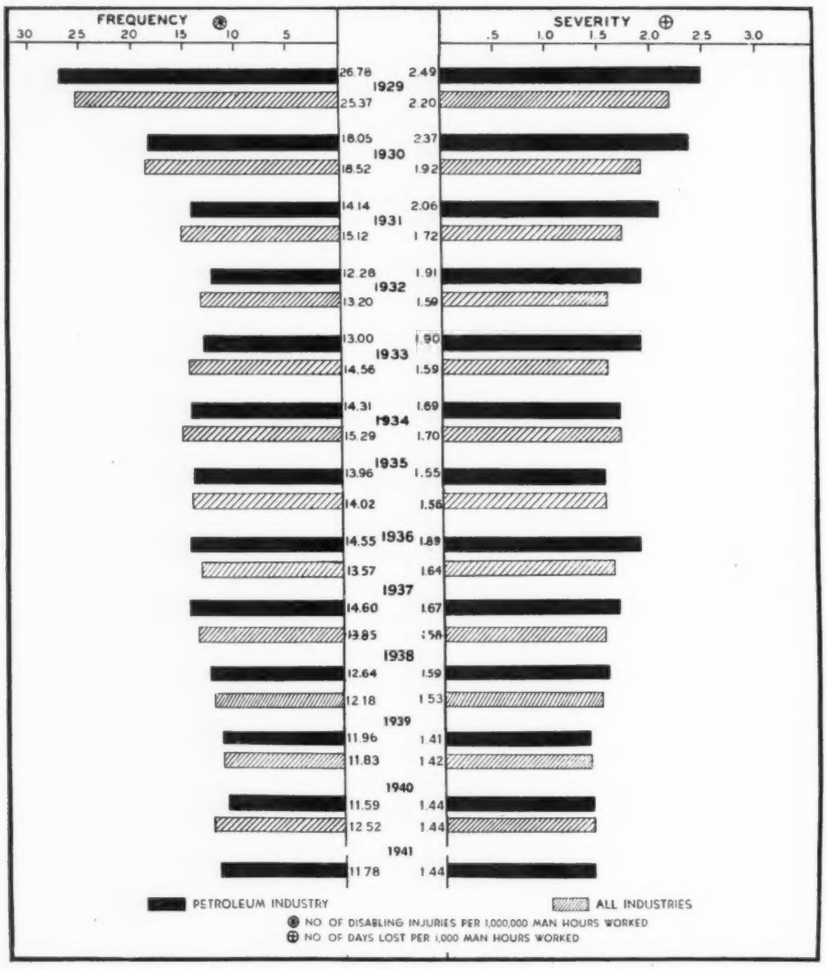
*Frequency and severity of disabling injuries, petroleum industry and other industries, 1929-41*



# Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines

☆ Simple energy and flow relationships of gases discussed

PETROLEUM ENGINEER Exclusive Feature

PART 1

*by Orville Adams*

CONSIDERATION was given to the effect of excessive friction in the air intake and exhaust systems of internal-combustion engines, in a previous article.[1] The relationship of certain fundamentals to the problems of supercharging likewise was discussed.[2] Many problems of this nature encountered in practical operation in the field, however, may be better understood and more efficiently solved when subjected to analyses and study, for no amount of observation will suffice without the application of the basic principles involved. Moreover, the phenomena of inertia supercharging, the question of "Why the column of air in a pipe 'stretches' when pulled at one end, and is later compressed due to velocity head, and why the optimum pipe length for exhaust or intake systems is shorter than the theoretical length,"[3] these and many other problems of air flow in ducts puzzle the operating man and engineer unless certain fundamentals are understood. In short, why is it important to give the engine a free exhaust, or a system without back-pressure? Why is the crankcase scavenging cylinder more sensitive to changes in the exhaust system than either the pump scavenged 2-cycle or the 4-cycle cylinder?

The general laws of fluid flow are applicable both to liquids and gases, whereas some energy relationships are better adapted to the study of only one form of such fluids. We are here concerned with relationships and conditions that occur only in the mechanical form of energy, such as pressure, volume, velocity, temperature, the thermal or chemical form of energy not being important to this discussion. Other relationships of conditions are discussed in which several forms of energy (heat, pressure, kinetic, etc.) are of sufficient consequence to require careful consideration in the problems involved. Example of such conditions are high-pressure, high-temperature gases or vapors flowing through nozzles or pipes at relatively high velocities. Some forms of energy are omitted from the equations as they are unimportant to the problems under consideration.

**ORVILLE ADAMS**

was educated at Kentucky State College and served in the technical branch of the army during the World War—After his discharge from the service he was for ten years sales engineer for Diesel engine manufacturers—Since 1930 he has devoted his time largely to the writing of text books and articles for leading technical journals—Is author of authoritative text books on the Diesel engine that are widely used in technical schools—Is also engaged in research and investigation and the preparation of engineering reports on Diesel engine applications.

## Conservation of Energy

The elementary idea of the First Law of Thermodynamics may be stated in many ways. It is frequently stated in a definite manner to include the Law of Conservation of Energy. Usually it reads: *"All forms of energy are mutually interconvertible, but no form of energy may be created or destroyed."* There are many possible forms of energy both before and after conversion. The basic idea underlying the Laws of Conservation of Energy is that although the conversion of energy from one form to another is possible, the destruction of energy is impossible. Degradation or degeneration in the form and intensity of energy is normal and natural, but destruction does not occur. For example, if a pound of oil having a heat value of 18,500 B.t.u. is burned and the heat is absorbed by a tank of water in raising the water temperature from 72°F. to 75°F., the energy of the oil is not destroyed but is degraded into a rather useless form so far as its power-producing potential ability is concerned. It is possible to account for all losses and list each one of 18,500 B.t.u. after the process is completed. Another analogy is the exhaust of steam into the atmosphere. After its escape into the air, it is no longer available in a useful form, but returns to its natural state. So long as the steam was under pressure, it had a useful form or potential for production of power.

## Energy Equations

Certain broad general equations for energy relationships of various processes have been proposed, and may be found in any handbook. For our purpose, they may be written as follows:

$$E_h + E_k + E_p = E_p + W + F + E_1 \quad \ldots\ldots\ldots\ldots (1)$$

where:

$E_h$ = the initial heat energy of the working substance,

$E_k$ = the initial kinetic energy of the working substance,

$E_p$ = the initial pressure-volume energy of the substance,

$E_h^1$ = the final heat energy of the working substance,

$E_k^1$ = the final kinetic energy of the substance,

[1] "Diesel Engine Performance Improved by Better Exhaust Design," *The Petroleum Engineer*, December, 1938.

[2] "Methods of Supercharging the Diesel Engine," *The Petroleum Engineer*, March, 1940.

[3] "Air and Air Filters for Diesel Engines," *The Petroleum Engineer*, September, 1939.

$_{2}p_{1}$ = the final pressure-volume energy of the substance,

W = the work or mechanical energy produced by the substance during the process, and

$E_t$ = energy gains or losses during the process; for example, heat lost or gained by radiation, convection, or conduction, changes in elevation before and after the process.

It is evident that such an equation is virtually useless and too general for application in practice; however, the various terms may be reduced, converted, or grouped for specific forms of energy relationships that are applicable to specific problems. Some terms of the general energy equation have been omitted for obvious reasons.

## Heat Energy Relationships

In considering heat energy as related to other forms of energy for use in this discussion, it is found practicable to make use of the following equation:

$$H_1 = I_1 + Ap_1v_1 \quad . \quad . \quad . \quad . \quad (2)$$

where:

$H_1$ = the total heat content of a unit of the working substance under condition 1,

$I_1$ = the intrinsic or internal energy of the substance at condition 1, and

$Ap_1v_1$ = the external work, a product of pressure and volume of the substance at condition 1. A is the reciprocal of J or 1/778, a factor that converts ft-lb. to B.t.u.

For any process involving heat content of a working substance undergoing a process from condition 1 to condition 2, the relationship, equation (2), may be written:

$$H_1 - H_2 = I_1 - I_2 + (p_1v_1 - p_2v_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The symbols have the same meaning as defined above; the subscript 2 designates the final condition after the process is completed. All terms in the above equation may be positive or negative, depending upon the reference point, and the expressions $H_1 - H_2$, $I_1 - I_2$ and $p_1v_1 - p_2v_2$ may become positive, negative, or zero, depending upon the process involved; for example, in the adiabatic process, $H_1 - H_2 = O$, as no heat is added or rejected. During such a process any work performed by the substance would occur at the expense of the internal energy, and the expression $I_1 - I_2$ would have a negative value.

The intrinsic or internal energy of a substance is the heat content within the substance existing as heat. Any potential energy of pressure, deformation, position, or velocity is not intrinsic or internal energy. These forms of energy are mechanical, and often are referred to as external energy. For lack of better reference point or base, the intrinsic or internal energy of a permanent gas is measured from the absolute zero. This base is practicable and simple and is certainly no more arbitrary than the use of 32°F. (0°C.) as a base for steam tables, and minus 40°F. as the base for refrigerant tables. The internal energy of a gas is, therefore:

$$I = wC_vT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

where:

I = intrinsic or internal energy in B.t.u. as used in equation (1),

w = weight of the gas, lb.,

$C_v$ = the coefficient of specific heat of gas at constant volume, and

T = the temperature of the gas, °F. abs.

The total heat energy of a gas consists of the intrinsic energy I, plus the external work Apv, and may be defined by the equation:

$$H = I + Apv. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

or

$$H = wC_vT + wRT \quad . \quad . \quad . \quad (4a)$$

or

$$H = wC_pT \quad . \quad . \quad . \quad . \quad . \quad . \quad (4b)$$

where:

R = the gas constant for the gas used, given in the customary unit ft-lb. per degree,

wRT = pv as above, and

$C_p = C_v + R/778$

These equations assume the case of the gas at rest. If the gas is in motion, particularly if at high velocities, the kinetic energy must be considered. In such cases, the total energy ($E_t$) is given by the equation:

$$E_t = H + \frac{wV^2}{2g\,778} = wC_p + \frac{wV^2}{2g\,778} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

or

$$E_t = wC_vT + Apv + \frac{wV^2}{2g778}$$

$$= wC_pT + \frac{wV^2}{2g778} \quad . \quad . \quad . \quad (6)$$

where:

$E_t$ = the total energy of the gas,

V = the velocity of the gas, ft. per sec.,

g = the acceleration of gravity, approximately 32.17 ft. per sec.,[4] and

778 = The Joules equivalent reducing ft-lb. to B.t.u.

For example: Find the (1) internal energy, (2) total heat energy, and (3) total energy of 2 lb. of air at 100°F., when moving through a pipe at the rate of 300 ft. per sec. The properties of air are $C_v = 0.1715$, $C_p = 0.240$, and $R = 53.34$.

Solution: (1) $I = wC_vT$
$= 2 \times 0.1715 \times 560$
$= 192.08$ B.t.u.

(2) $H = wC_pT$
$= 2 \times 0.240 \times 560$
$= 268.8$ B.t.u.

(3) $E_t = H + \frac{wV^2}{50{,}056} = 268.8 + \left(\frac{2 \times 300^2}{50{,}056}\right) = 272.4$ B.t.u.

In part 2 of the above solution, observe that the gas contained 268.8 B.t.u. in the problem involving 2 lb., and that the kinetic energy of the mass (Part 3) in motion is approximately 3.6 B.t.u. That is, it required 3.6 B.t.u. of work ($3.6 \times 778 = 2800$ ft-lb.) to accelerate the mass of gas, and if the gas is brought to rest by friction this amount of kinetic energy will be transformed into heat and may be absorbed by the air.

Observe that the elevation of points 1 and 2 are not mentioned; and air and gases or vapors weigh so little that the potential energy due to a few feet difference of elevation may be neglected. So far as absolute accuracy is concerned, the potential energy of elevation should be included in the calculation; however, when a column of air at normal atmospheric conditions must be nearly 2000 ft. in height to exert a pressure of 1 lb. per sq. in., it is obvious that other errors in caculation or data may far exceed the entire factor of the elevation difference involved.

Other factors that are extremely important, such as friction, will be discussed.

EDITOR'S NOTE: Part 2 of this article on "Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines," will appear in an early issue of *The Petroleum Engineer.*

[4]The value of 2g778 is $2 \times 32.17 \times 778 = 50{,}076.5$, and the use of round numbers (50,000) introduces an error of less than 1/10 of 1 percent.

☆ ☆ ☆

# Repairing Casing Leaks

☆ In older fields, where earnings of wells are limited, the work must be done in an orderly and economical manner

*by F. J. Spang*
President, Spang and Company

THE making of casing repairs is of considerable importance. In the older settled producing fields, where the earning capacity of small production is low, it becomes a necessity to do this work in an economical and orderly manner. In the past it has not been uncommon in such fields to run an inside string of smaller casing and set it on a packer at some point below the casing leak. With the present scarcity of casing, however, caused by war conditions, this method can no longer be followed in many instances. There are several methods that may be used to remove and replace a leaky joint with a joint of good casing.

In performing this work the equipment must, of necessity, be of a size and type that permits it to be done safely and in an orderly manner. For this reason a standard or portable rig is desirable when casing strings are rather long. The standard rig equipment may be used or, in its absence, any heavy well-servicing unit will perform equally well.

In shallow territory, where casing strings are shorter, a pole or mast with sufficient strength to lift the weight of the casing will suffice. With a pole or mast a suitable well-servicing unit can be used, and in some cases a common pulling machine will answer the purpose. In any event, provision should be made for cleaning out the hole after the casing has been repaired. Obviously, this means that provision must be made for mixing the sediment that may be washed into the hole and the removal of it either by a sand pump or a bailer.

## Removable Bridge Set

The first step in preparing the job for casing repair is to set a removable bridge either in the casing below the leak or, preferably, in a solid hard-walled portion of the open hole below the casing seat in a spot that would not expose a formation likely to cave during the repair job. The bridge may be started by using a small forked tree or bush center. (See Fig. 1.) Sufficient burlap sacks to make a temporary support are placed on top of the bush and sand pumpings and clay are then dumped above it in sufficient amount to prevent leakage through the bridge; (See Fig. 2) or, the bridge may be of a mechanical design such as illustrated in Fig. 3.

**F. J. SPANG**

**has been associated with Spang and Company since his early youth and succeeded his father, George A. Spang, to its presidency upon his death about seven years ago—His experience in the oil industry has been of a practical type, although he has kept abreast of technical and executive requirements, having been active in A.P.I. committee work almost since the beginning of its standardization program.**

## Finding Leak

When the bridge is set and the hole made tight by sand pumpings and clay, the hole should be baled-out and a casing tester run to find the leak and determine its volume. A casing tester may be made of 1-in. or 1½-in. pipe 2 or 3 ft. long. The top of the pipe should be threaded about 4 in. A casing size leather, rubber disk, or diaphragm is fitted between two metal washers slightly smaller than the casing and held in place on the pipe by means of two pipe size lock nuts. A tee with the opening at the side is screwed on to the thread above the diaphragm and a bail or eye screwed into it. The lower end of the pipe is capped. (See Fig. 4.) The casing tester is run on the measuring line. The leak is found by running to different depths until found. Unless previously known, the volume, if rather large, is measured by gauging the fill-up time in the hole or bailers per hour. If rather small it can be gauged by the tester.

After the location of a leak has been determined, the hole will fill up to the water level through the leak. If the leak is small, it may be advisable to fill the hole to, or above, the water level. This filling of the hole will eliminate much of the sedimentation cave that normally occurs when the inside of the casing is filled to the water level. In event the hole is being filled with outside water it is frequently of some advantage to mix this filling water with clay. Although the leak is large and would fill the hole rapidly to the natural water level, some advantage may be gained by over-filling it with a clay solution. The over-filling will tend to reverse the flow of the water and carry some clay, with its lubricating qualities, behind the casing. This is of more importance when there is a tendency toward caving, as in such cases a heavier fluid will tend to retard the caving.

## Removing Casing

When this procedure is completed, the next step is to remove and examine any casing that can be unscrewed from the rest of the string. To do this a slight tension should be taken on the casing, preferably with casing blocks having a swivel or swivel hook between the blocks and the elevator. The tension should be only sufficient to lift the weight of the casing as far down the hole as the casing is free. Changes in casing lengths at rest and under compression or extended stress are shown in Fig. 5, which needs some explanation. On the graph, Fig. 5, the determining curve begins at zero in

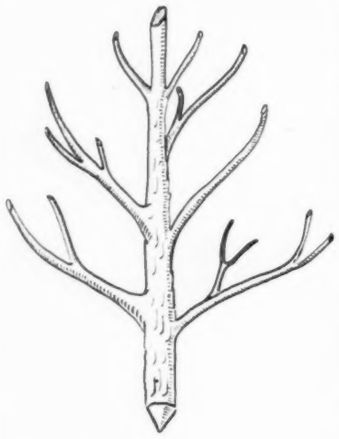


*Fig. 1. Bush center used to start bridge*

the lower left-hand corner. This curve rises rather sharply and then flattens out somewhat. The stretch in inches is shown on the lower side of the diagram, and the length of the string is shown on the left border of the diagram. Thus, a string of casing 3000 ft. long supported from the bottom (i.e., freely set on bottom) would compress a matter of 6 in. compared with the length of a similar string of casing lying on the ground, but it will also stretch another 6 in. when it is suspended from the top.

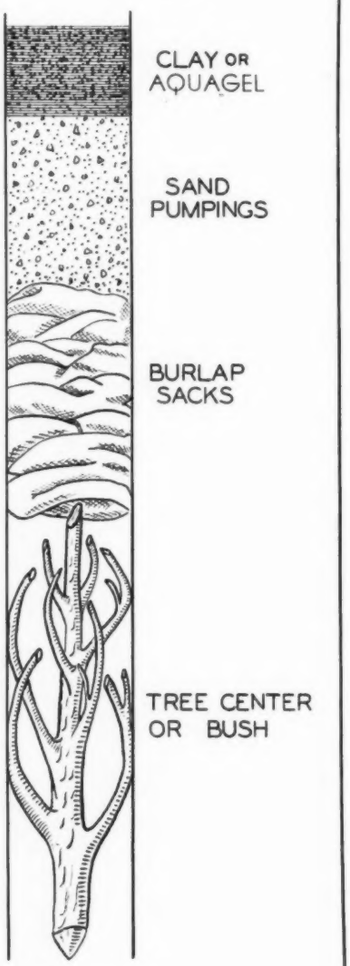
Thus, in order to free a casing coupling from either downward or upward stress at a 3000-ft. level, the string of casing must be raised 6 in. plus 6 in., or a total of 12 in. at the surface. To free a casing coupling from such a stress at 2000 ft. requires the raising of it at the surface 3 in. plus 3 in., or a total of 6 in. At 1000-ft. depth it would be a total of 1½-in. to 2 in. of a raise. It is, of course, evident that this is the case only when the string is loose in the hole and free to move without other stresses.

Now, if records in the territory indicate that one might expect casing to be free above the leak point, then the casing should be raised only a sufficient distance to allow the stress to be removed from a point somewhere below the leak and an effort made to unscrew the casing at some one of the couplings below that point. Obviously, it is unlikely that the casing will unscrew at a higher point because of the stresses that will exist in the upper section.

As the casing unscrews it should be raised slowly upward in order to keep the stress off the threads that are being unscrewed. This may be done in any suitable manner, but unless it can otherwise be done orderly it should be done by tramping or cranking the engine, with all clutches engaged. If a multi-cylindered engine with a self-starter is being used, it may be done by running the starter with the transmission in low gear.

In event the casing should become unscrewed at some point above the leak it is, generally speaking, worth while to remove this casing from the hole and either re-run it with a substitution of new joints where needed (the latter in the top end of the string), or to run new casing. It is always an advantage to have as much good casing as possible in the hole, with the best at the top end. In event the casing does not begin to unscrew, it is evident that it is tight (frozen) at some point above the point selected and to which the stress should reach. Such a condition results in excessive stress above the tight or frozen area and such excessive stress will not permit the threads to move. Therefore, if it is desired to unscrew above the tight or frozen area, the stress should be lessened gradually until unscrewing is begun.

*Fig. 2. Burlap bags, sand pumpings, and sand used to prevent leakage through bridge*




## Rerunning Casing

When a portion of casing that has been pulled is to be re-run the joints should be set as tightly as practicable. When it has been run to the point where it is to be screwed onto the casing that is still in the hole, a centering guide should be run inside of it. (See Fig. 6.) This guide should be made about ¼ in. to ⅜ in. in diameter smaller than the inside of the casing. It should be made of pipe and the lower end bullplugged or pointed leaving a small hole to permit the entrance of, and draining out, of fluid when it is run into the fluid. It should not be less than 6 ft. long (preferably 8 ft. or longer) with the top end made similar to a swage nipple so that it may be run on tubing.

The upper section of casing being run should be stopped a little above the coupling and the guide run so that a part of it extends into, and between, the two sections of casing. If it is run on tubing a tubing clamp or spider may be put on it and be supported on the top end of the joint of casing while the casing is lowered into the collar seat and screwed-up. Obviously, the guide may be run on a sand line with a small string of tools above it, but whether tubing or the sand line is used, very careful measurement of both the casing and the tubing, or sand line, should be made so that the guide may be placed properly and the work at the surface done to the best advantage and with the avoidance of damage either to the coupling or to the casing thread.

When the upper section of casing is made up to the lower section of casing the guide should be removed and the casing gradually raised and the tightening continued until a screwing-up action takes place at a coupling at some point below the leak. As different couplings are screwed-up it may be necessary to ease the casing downward to keep the threads free. After each joint is tightened the casing should be set down and new surface marks should be made to establish a new stress point.

When a joint below the leak gives way during make-up it should not be tightened, but the same stress should be maintained and an effort made to unscrew the casing at this point. If this is successful, that portion of the casing may be removed and a replacement joint substituted for the leaking joint. This section of casing may then be re-run and screwed on in the manner described above. After it has been screwed onto the lower section of casing, rais-

ing and tightening should continue in order to tighten as much of the string as possible.

### Other Methods of Separation

If it has been found impossible to separate the casing at a coupling below the leak there remain several methods of solving the problem. One of these is to cut the casing at a point below the leak and put it together with a lead packing collar. (See Fig. 7.)

To cut the casing a safe stress should be applied to it, and this stress should extend to a point somewhat below the leak. When the cut is made and the casing removed, the cut should be examined to see that it is in good order and not too close to a coupling to prevent the skirt of the lead packing collar from passing down over the outside of the casing far enough to permit the lead seal to be effectively seated.

If it appears that the cut might be too close to a coupling, the casing cutter may, if desired, be run to a safe point (which may be determined by the joint removed) and another cut made that can be removed on the cutters. Obviously, this must not exceed one or two joint—preferably only a part of a joint—of casing if the casing is to be removed on the cutters. To remove the casing on the cutters requires that the mandrel line be stripped through the tubing as it is laid down; therefore, if the depth is considerable, it may be best simply to raise the section of casing to insure that it has been completely severed and then remove the cutter and make a run for this section with either a bulldog or a trip spear.

In case it is not possible to cut and remove the casing below the leak, several cuts can be made at different levels until the top section comes free and these sections then removed with a bulldog or trip spear.

### Removing Complete String

Should it not be desirable to repair the casing by the cutting and packing collar method, the removal of the full string may be desirable, provided, of course, that the lower end of the casing is not cemented in place. The casing should first be screwed-up to a reasonable tightness throughout as much of the string as possible. Before doing this, however, it would be well to remove the surface joint and substitute a new joint at that point. Then, by gradually raising the string, and at the same time tightening it, each loose joint can be tightened. Obviously, if any particular joint tightens to any considerable degree, this screwing-up action will tend to raise and free the joint below it. Consequently, no raising should take place until after the casing is lowered to its natural setting position and it is marked at the surface to establish subsequent stress points. In other words, the process of finding the free position of joints can best be

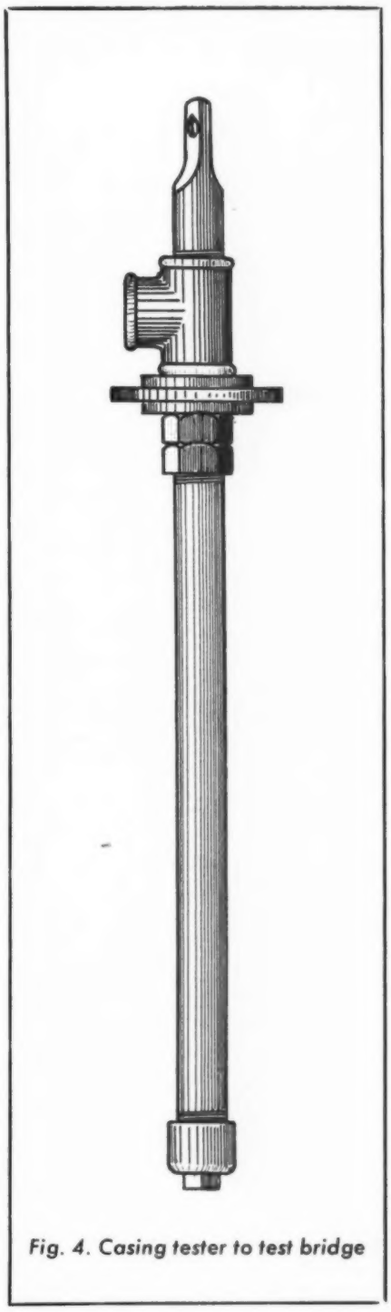


*Fig. 4. Casing tester to test bridge*

*Fig. 3A. Running to set bridge. Fig. 3B. Packing bags. Fig. 3C. Pulling burlap bags. Fig. 3D. Running for bridge*

*Fig. 3A*

*Fig. 3B*

*Fig. 3C*

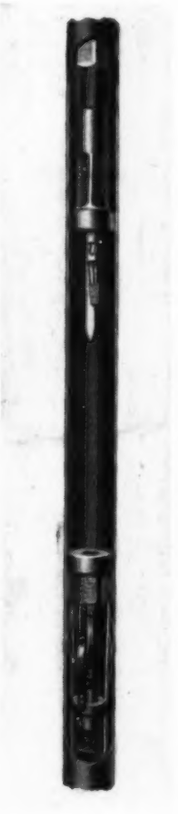


*Fig. 3D*

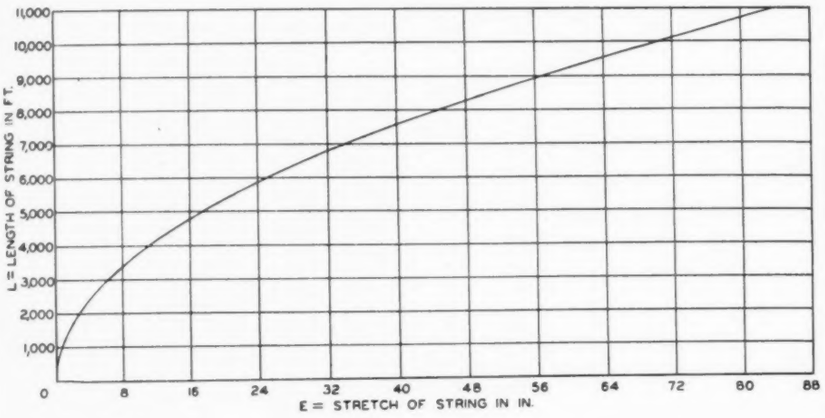



*Fig. 5. Curve based on Young's Modulus of Elasticity*

$$e = \tfrac{1}{2} \times \frac{12\ PL}{29{,}000{,}000\ A} = 0.000000703365 \times L^2$$

Where: e = Elongation, or stretch in inches,

P = Weight of string in lb. = WL = 0.2833 × 12 × LA,

L = Length of string in ft.,

A = Area of pipe wall in sq. in.,

W = Pipe weight per foot complete.

Note: As the average load will only be equal to ½ the length of string "e" will be an average value.

Elongation or stretch obtained from curve is for strings freely suspended by one end.

For strings suspended in salt water, use approximately 85 percent of values of "e" and for strings suspended in rotary mud use approximately 82 percent of values of "e" obtained from curve.

If string is resting freely on bottom, it is compressed by a like amount.

Curve is not applicable above yield point of material in question.

done by finding such point after the casing is at rest.

After the casing has been tightened as much as possible (within safe limits), the working of the casing should begin. If the derrick or mast is of sufficient strength, and a suitable servicing unit is being used, it is possible to work the casing by simply churning it up and down with the engagement and disengagement of the clutch. In some cases the process will be long and tedious and cause considerable wear in the machinery.

There is now on the market several types of hydraulic casing-pulling units. Casing may be churned or worked fairly well with these units. It is, of course, obvious that one must carefully determine the safe capacity of the casing in using this equipment, or any other method of working the casing.

In the absence of other suitable means, casing may be worked by logging. To do this a log or beam should be mounted on a fulcrum support on one side of the casing to work as a lever on the casing elevators. The elevator bales may straddle the beam and be wired together with a bar across, or they may be attached beneath the beam by means of a short length of clamped cable or any suitable connection. The other end of the beam is then attached to the casing blocks. The end of the beam measurement from the fulcrum to the center of the hole should be about 3 ft. and from the center of the hole to the point where the blocks are attached, 5 to 6 ft.

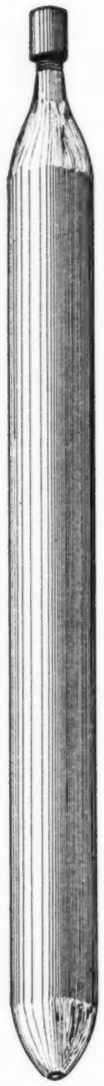
The surface point of the casing should then be marked and a mark also put on it showing the maximum stress that was imposed during the tightening operation. Obviously, this latter point should be a safe one that will not overstress the casing. The casing blocks should then be raised and lowered repeatedly to stretch and rest the casing. At first the safe point should not be exceeded, but after a number of stress and rest cycles a little additional stress can be imposed, thus the stress point will be gradually increased.

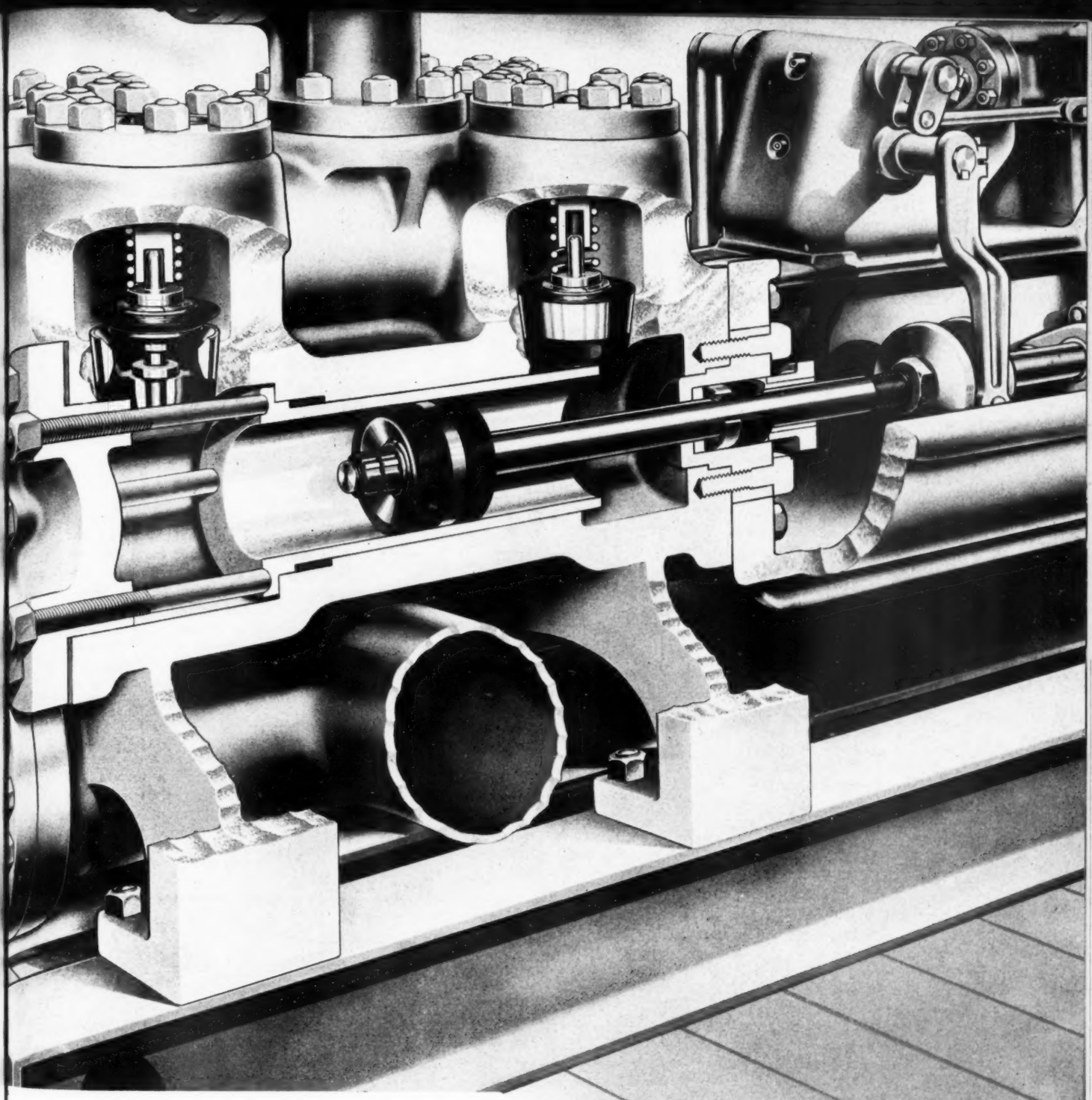
The purpose of working the casing is to break up the sediment that may hold it at any particular point. To be most effective the end of the casing line may be run over the spudding attachment in an appropriate stroke. If this can be done with either end of the casing line attached to the drum the stress can be gradually increased without changing the hitch, but if there is no method to increase the stress and at the same time use the spudding attachment it may be possible to mount the beam fulcrum on the casing jacks, and these may be gradually raised to increase the tension. If this is done the beam should be set so that the block end is relatively high at the beginning and thus relatively low at the completion of the working operation.

Reasonable judgment in performing the working operation is necessary, and, obviously, it should not be continued for any great length of time as to do so might cause fatigue and the casing to part at some undesirable point, but

*(Continued on Page 42)*

*Fig. 6. Centering guide for re-running casing*





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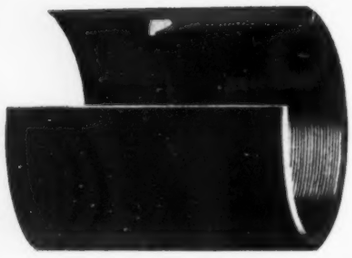


*Fig. 7. Lead packing collar*

*(Continued from Page 38)*

in many instances it is possible to free frozen casing by this method. Intermittent with the working of the casing, and after abandoning it, the casing should be screwed-up in the manner previously outlined.

### Running a Trip Spear

If the working operation fails to free the casing, it is necessary to run a trip spear to do so. (Fig 8.)

Obviously, it is important that the spear be clean, that the slip teeth are sharp, and that it is in proper working condition before each run. Setting instructions, as well as the casing size and weight for the spear used, should be carefully observed. If there is considerable danger from sand and sediment, the slip recesses and all openings should be carefully "doped" with a heavy grease such as mica axle grease. Before running the spear a reasonable stress should be taken on the casing and it should be landed in a floor spider or a screw casing jack. (Equipment shown in Fig. 9 may be used.)

The trip spear should be run on fishing jars of 36-in. or longer stroke, placed below the stem, and a hold taken relatively close to the bottom of the string of casing. The hold is taken by a stiff upward pull followed by a very tight hitch so that the first motion stresses the drilling cable rather than works the jars. This is to seat the slips and wedge the spear tightly between them. The line may then be let out slowly until an upward jarring action occurs. As soon as a fair report of the jarring action can be felt on the cable the blow should also telegraph a report through the casing. If no report comes up through the casing it is evident that the casing is frozen or is tight above the spear causing the vibration to be dampened out at that point. In such event the jarring action should not be continued more than a very few moments, nor should it be of any great magnitude, as to do so may damage the casing either at the spear or at a coupling.

When no further jarring is to be done the spear hold should be released by tripping. To trip the spear the line should be let out or lowered and a loose hitch taken. A few downward blows should be struck and an effort then made to pick up the spear. Long, or hard, downward jarring on the type spear illustrated (Fig. 9) can damage it and prevent tripping. If the stroke of the fishing jars is long enough to strike a fair downward blow and a light upward blow at a slow motion, it should result in lifting the spear and freeing the hold.

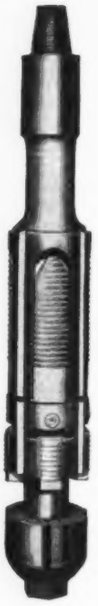


*Fig. 8. Trip spear*

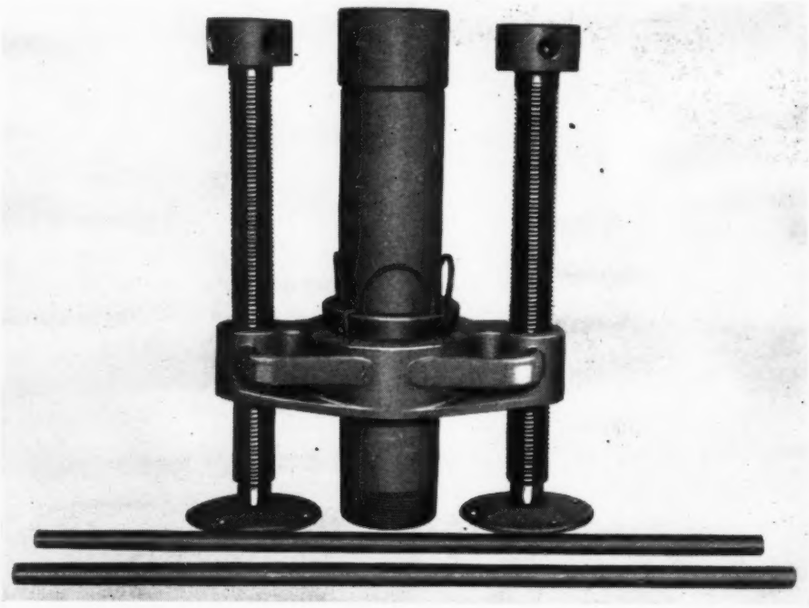
A slow motion for tripping the spear is essential, but if a long stroke is not possible then a few downward strokes should be struck and an effort made to lift the spear, repeating the process until tripping occurs. This type spear is tripped by downward jarring but only an upward lift will free it from the casing because of the action of the lower, or tripping, slips. Frequently it may be tripped by simply taking a stress on the cable and dropping the tools quickly.

After the spear has been tripped it should be brought to the surface for examination, re-greasing and re-setting before it is run again for a second hold.

This second hold should be up the hole some little distance from the first hold, say 50 to 100 ft. higher depending upon the formation and the likelihood of sediment behind the casing. If this second location telegraphs a report through the casing a very limited amount of jarring should be done but not enough to cause the casing to "jump off" at a coupling.

If it does not telegraph a report through the casing the spear should be moved to an upper point and this procedure continued until a telegraphed report is received. When the telegraphed report is received through the casing the spear should be tripped, brought to the surface, re-set, and run to a point

*Fig. 9. Floor spider or screw casing jack*



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somewhat below the point that telegraphed the report. This distance may be about 50 ft. lower. The object of this procedure is to find and place the spear in the uppermost frozen or tight area.

If no casing report is now received, jarring should continue until it is received, but as quickly as it is received the spear should be tripped, pulled, set, and re-run to another slightly lower point. This step-by-step process should be repeated until the spear is finally set down next to the bottom of the casing. At no time, however, should it be moved downward until the casing report is received, and jarring should not be continued in any of the other points after the casing report is received.

This method of establishing the free point of the casing and setting the spear for action just below it in a tight or frozen area lessens the likelihood of damaging the casing or couplings by excessive jarring at a point below where the casing is tight. Obviously, if considerable jarring were done at a point where the casing were free, and this point was below the tight point, there would be danger of injuring the casing at the point where the trip spear had its hold or loosening or damaging the couplings above it.

By following this procedure the casing will be loosened through each tight point and the jarring action, even though moderate, will tend to loosen the sediment behind it. Thus, the stress taken at the surface may pass downward through the casing to a lower point each time an upper point is freed, thus aiding in greater degree as greater depths are reached.

Once the free point is found and the spear lowered each time the casing report is felt at the surface, some additional stress may be imposed on the casing at the surface. In other words, if 100 ft. of casing has been freed from the wall sediment then 100 ft. of casing is ready to absorb its share of surface stress. This procedure, if followed carefully, will generally free any string of casing.

As already stated, it is absolutely necessary that destructive stress at the surface be avoided, and that trip spear action be moderate with the trip spear situated at a point where it is working on the tight part of the casing. This procedure will consume somewhat more time, but it will eliminate the risk of many serious fishing jobs and will save for future use much of the casing that may otherwise be destroyed.

The setting of casing in relatively weak clay solution, and the filling of the back of the casing with clay is just one of the things that will save for the producers of petroleum and natural gas considerable money by the elimination of many costly casing jobs and by making those that do occur simpler and easier to handle.

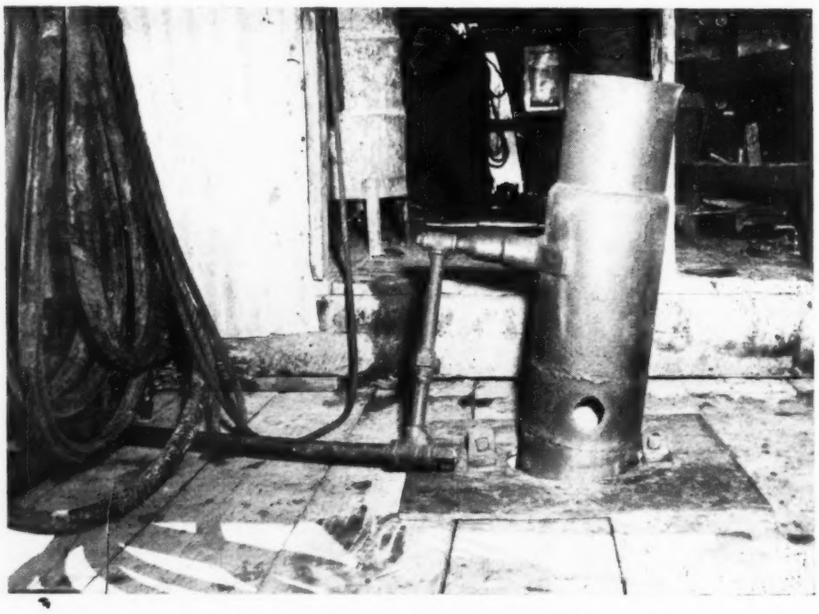
☆☆☆

P 422.000.

# Drill Stem on Rotary Rig Cleaned with Steam

AN unusual, though thoroughly effective, method of cleaning the kelly or drill stem has been put into practice on one of the steam rotary rigs of a major drilling company at present engaged in drilling a deep gas well in the Chapel Hill field of East Texas. As may be seen in the photograph, the pipe in the rat hole has been belled at the top to facilitate entrance of the drill stem. About a foot below the top of the pipe a steam jacket has been welded around the pipe with an annular space of about 1 in. To the jacket is connected a steam line from the feed of the mud pumps. Inside the rat-hole pipe and in the area covered by the jacket, approximately 100 holes have been drilled ⅛ in. in diameter.

Thus when the drill stem is run into the rat hole at the beginning of a trip out of the hole, or when waiting to set in another joint of drill pipe, it is "steam cleaned" as it is run in to remove drilling mud, old lubricant, etc. A part of the waste cleaned from the drill stem and mud from the rotary hose drain down into the rat-hole pipe and a part drains off to the side beneath the rotary floor through a number of holes about 2 in. in diameter cut with a torch. When the rat hole fills to the surface of the ground it overflows onto the ground through the 2-in. holes. When the drill stem is pulled from the rat hole to resume drilling, it is again "steamed cleaned" and when placed in service has no grease or mud to drain off on the rotary table or derrick floor. The steam valve in the line to the jacket is shown to the left in the picture.



*The line shown carries steam to a jacket encircling the rat hole pipe*

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## ☆ Reference list for those interested in doing research reading on this important and timely subject

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**EDITOR'S NOTE**

**Because of the great interest at this time in the synthesis of rubber, and to meet the many requests that have been received for literature on the subject, the accompanying bibliography is published. Acknowledgment is made to the Technical Department of the Tulsa Public Library, Tulsa, Oklahoma, which made this compilation available.**

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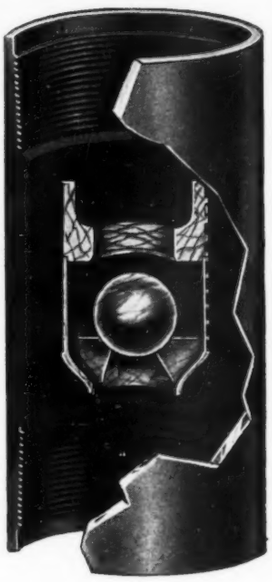
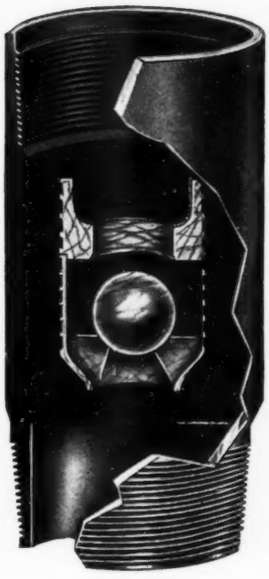
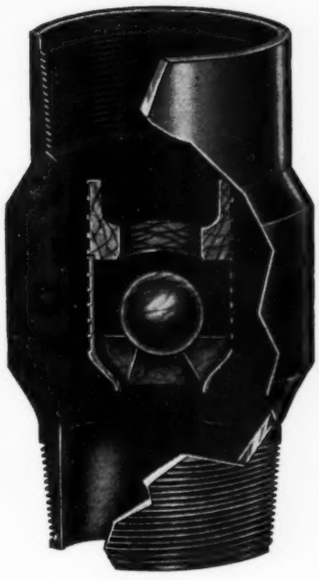

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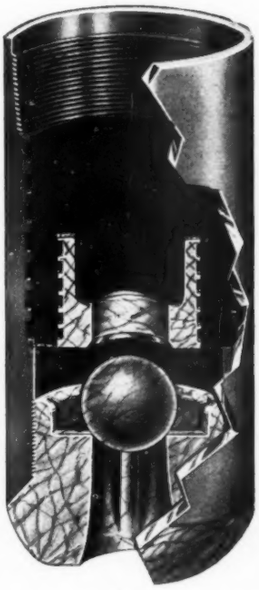

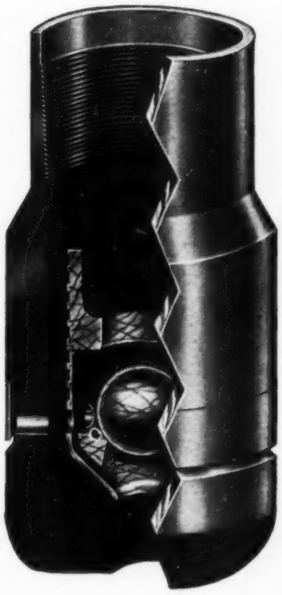

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# Preference Rating for Petroleum Enterprises Abroad

A new method of assigning preference ratings to orders for export was adopted April 25 by the War Production Board. Immediate application of the new method is limited to exports for petroleum enterprises outside the United States and Canada.

Priorities Regulation No. 9, issued by the Director of Industry Operations, will govern issuance and use of ratings for export whenever appropriate forms are approved for specified industries or products. The most important provision of the regulation is that a preference rating assigned under its terms to a product for export may not be applied without an export license or other authorization to export, and the rating will be automatically cancelled if the export license or authorization is revoked. This will help to prevent burdening transportation and dock facilities with materials that cannot be exported.

The first approved form to be issued under the new regulation is Form PD-311, which is an application for priority rating on materials to be exported for the use of the petroleum industry. Preference ratings for export may be assigned to applicants on this form on substantially the same basis as ratings assigned to petroleum enterprises in the United States and Canada under the petroleum industry Preference Rating Order P-98. Ratings assigned on Form PD-311 may also cover materials for construction and maintenance of natural gas lines, which are not included under P-98.

Applications on Form PD-311 will be processed by the Office of Petroleum Co-ordinator in cooperation with the Board of Economic Warfare, Lend-Lease Administration, and the War Production Board. Detailed instructions for petroleum companies applying for preference ratings on this form have been prepared by the Office of Petroleum Co-ordinator.

Simultaneously with the issuance of Priorities Regulation No. 9 and Form PD-311, Preference Rating Orders P-98-a and P-103-a, under which ratings have previously been assigned to exports for the petroleum industry, have been revoked.

# Relief for Illinois Under M-68

Petroleum Co-ordinator Harold L. Ickes outlined May 21 to Illinois operators the conditions under which wells may be drilled in Illinois fields closer than one well to 40 acres as now required under Conservation Order M-68.

The OPC statement follows:

"Recognizing the proximity of the Illinois fields to the important war industry centers of the Midwest and on the Eastern Seaboard, the Co-ordinator announced that Illinois operators may expect a relaxation in the spacing requirements of Conservation Order M-68 for those pools and fields where the physical conditions justify such action.

"It was pointed out that the arrangement does not require an amendment to Order M-68 but is adaptable under the provisions of the order, as it now stands, which provide for the approval of exceptions for entire pools and fields under certain circumstances.

"Under the announced plan applications for exceptions to Order M-68 will be accepted for the present time from Illinois operators and favorably considered on the basis of well depth, when the physical producing conditions warrant, along the lines of the following proximate rules: 5-acre surface spacing for sand reservoirs at a depth of 500 ft. or less; 10-acre surface spacing for depths greater than 500 ft. and less than 1500 ft., and 20-acre surface spacing for depths greater than 1500 ft. and less than 2500 ft."

# M-68 and M-68-c Apply Only to U. S.

Because the export of supplies for the petroleum industry is now controlled by the Foreign Petroleum Material Rating Plan, the petroleum industry conservation orders M-68 and M-68-c have been amended to make it clear that their provisions apply only in the United States, United States territories and possessions, and the Dominion of Canada.

Canada remains included within the scope of the conservation orders because Canadian producers and distributors of petroleum and petroleum products are expected to be made eligible to receive priority ratings under Preference Rating Order P-98 on the same basis as the companies in the United States, when a copy of the order is addressed to them with a serial number.

Conservation orders M-68 and M-68-c limit the use of materials in the production and marketing of petroleum and petroleum products, and control the use of ratings under Preference Rating Order P-98.

Preference Rating Orders P-98-a and P-103-a, under which preference ratings were formerly assigned to petroleum enterprises in foreign countries, have recently been revoked, and it is therefore considered unnecessary to apply the provisions of M-68 and M-68-c to foreign countries.

Today's (May 21) action was taken in Amendment No. 4 to Conservation Order M-68 and Amendment No. 1 to Conservation Order M-68-c as previously amended.

# Aromatic Petroleum Solvents Deliveries Under M-150

With the objective of increasing the production of aviation gasoline and nitration-grade toluol, the War Production Board has issued an order limiting the delivery of aromatic petroleum solvents, normally used in paint and other protective coatings, to orders bearing high preference ratings.

The order (M-150, effective May 25) is designed to divert more than half of the two principal aromatic constituents of petroleum solvents—toluol and xylols—from use in the protective coating field to the more important production of aviation gasoline and nitration toluol.

The principal provisions of the order follow:

1. Deliveries may be made only to fill orders to which certain preference ratings have been assigned. During the period June 4 to June 14, the required rating is A-10; beginning June 15, the required rating is A-2. A person purchasing solvents for resale without physical or chemical change is not required to show a rated use.

2. A purchaser, other than a person buying for resale, is required to attach to the order a certification showing the purposes for which the solvents are to be used.

3. Each producer of solvents must accumulate before July 1, or as soon thereafter as possible, a minimum inventory amounting to not less than 25 percent of his average monthly production of each solvent produced during the first four months of 1942. This reserve stock will be held for distribution by the Director of Industry Operations in emergency situations.

To the extent that withdrawals from the pool are ordered by the WPB, a producer must replenish the reserve at a rate of not more than 5 percent of average daily production.

4. After making deliveries on rated orders and setting aside the inventory stock, each producer must divert his remaining supply of solvents, whether in the form of finished product, intermediate fraction, or crude petroleum, to the production of nitration toluol or aviation gasoline as ordered by the Director of Industry Operations. The aviation gasoline so produced must be delivered solely in fulfillment of contracts or subcontracts of the Army or Navy.

5. No person is to use the solvents for any purpose if suitable substitutes are available.

6. Solvents may not be received by any producer or distributor if the delivery would result in a supply in excess of 30 days' needs.

# Use of Scarce Materials Must Be Curtailed

The Director of Materials, of the Office of Petroleum Co-ordinator is calling to the attention of the petroleum industry the fact that the War Production Board is finding it necessary due to the scarcity of certain materias, to take drastic action in eliminating them so far as possible when included in applications for project rating. It suggests that applications for project ratings made out in strict conformity with Form PD-200 and PD-200a, and in conformity with the rulings of the War Production Board will be expedited much more rapidly than if this is not done.

The War Production Board has declared that the following materials, most of which are used at times by the petroleum industry, are scarce materials, vitally needed for war purposes and in general are termed critical: aluminum, asbestos, cadmium, calcium-silicon, chromium, cobalt, cork, copper and copper alloys, lead, magnesium, plastics, nickel, rhodium, steel and iron of all types, and their alloys, tin, tin plate and terneplate, tungsten and tungsten carbides, vanadium, zinc and zinc coated metals, cotton duck, manila fiber and cordage, jute, burlap, Kraft paper, lead, manganese, mercury, sisal, and rubber of all types, new and reclaimed.

Engineers designing plants for which a project application will be made should take into consideration the vital and scarce nature of these materials and in every instance should eliminate their use if it is at all possible to do so, finding substitutes therefor, and where total elimination is not possible, reduce the quantity as much as possible.

The materials branches of the War Production Board are denying the use of certain classes of materials and equipment as follows:

1. Galvanized iron and steel pipe, except when the properties of the water demand zinc coating.
2. Steel water tanks (except closed pressure types).
3. Both black and galvanized corrugated iron and sheet for side walls and roofs for buildings.
4. Eighty-five percent magnesia pipe covering for insulation purposes except when temperature exceeds 212° F.
5. Metal base plumbing fixtures.
6. The use of cork for insulation except when extremely low temperatures are required.
7. Valves and fittings that are trimmed with chromium, stainless steel, bronze, brass, or nickel except to meet special processing requirements. Valves greater than 2 in. with brass bodies are usually prohibited.
8. Steel sash, windows and frames, steel bucks, steel doors and frames, steel roof decking, metal roofing, except where extreme fire hazards exist.
9. New steel storage tanks to be used for fuel oil, crude oil, and other heavy oils whenever it is practicable to construct concrete storage tanks.
10. Cast-iron soil pipe, or sewage pipe except those of standard weight and then only those portions required within a building.
11. Ferrous metal for water mains when the use of asbestos cement, concrete, or wood pipe is practicable.
12. Water well screens made of brass, copper, and other non-ferrous alloys. Gravel-packed screens or screens of other types will serve the purpose for a reasonable length of time.
13. Steel wire fence of the chain link type.
14. Ferrous metal culverts.
15. Electric conduit (metal) where wiring can be safely installed without it.
16. Standby equipment. Spare parts to be held to a bare minimum.

Construction equipment of all kinds and oil-well drilling equipment must not be included in a project application as such equipment does not become a permanent part of the finished project.

Machine tools, rubber products, chemicals, business machines, office furniture, office supplies, automobiles, trucks, and tires should not be included in project applications; there are special orders governing the rating or distribution of these materials.

Aluminum and steel plate are on allocation and are being allocated only to those projects that are extremely important in the war program. Projects should be designed so far as possible to minimize or eliminate their use. Every effort should be made to keep steel plates under $\frac{3}{16}$ in. when steel plates must be used.

The most critical materials are aluminum, stainless steel, chromium steel, nickel, tin, and copper. It is probable that items of material requiring these alloys will be denied by the War Production Board unless accompanying information is provided with the project application explaining why these alloys must be used, why no substitute can be used, and a further statement to the effect that the percentage of critical metals in the alloys has been reduced to a practical working minimum.

The petroleum industry's refining projects re-

quire a great deal of chromium steel. The War Production Board is insisting that projects be designed with the least amount of chromium or other alloy metals possible. The War Production Board suggests that where scarce alloys are necessary, we plan on frequent replacements, if by so doing we are able to reduce the amount of such scarce materials, unless such replacements would cause extraordinary expense, such as tearing down boiler settings, etc. Frequently 1½ percent chromium steel will give two years service in equipment that is usually designed with 4-to-6 percent chromium. Every pound of chromium steel the petroleum industry uses must be taken from a ship or a shell, and consequently, every pound of chromium steel is precious. All steel plate is being allocated and only those projects that are the most important in the war program are receiving it. The ship-building program is behind schedule because of the shortage of steel plate; therefore, projects should be so designed as to minimize to the greatest extent possible the use of steel plates and sheets.

Steel storage tanks require plate for the large sizes and sheet for the small sizes. Before requesting new tankage, every effort should be made to find available second-hand tanks that can be cut down, moved, and re-erected.

All large compressors are now on strict allocation and are not available except for the most vital projects. Whenever compressors, pumps, electric generators, or motors are required, every effort should be made to find second-hand equipment that will do the work. They are all scarce and critical.

When tubular goods are required use second-hand materials whenever possible. Salvage unused lines and if possible lines that are not operating to capacity. Whenever new pipe is required, a size should be chosen only sufficiently large to carry the amount of fluid that must be handled, and the weight of the pipe should be consistent with the pressure under which it must operate. Use the smallest and lightest pipe possible. Do not allow for greater capacity or greater pressure that might be required at some later date. Seamless pipe and tubing are not available except when required in processing equipment subject to high temperatures and high pressures. When possible, specify welded pipe in your application.

Buildings and other structures should be designed to use as little structural or other steel as practicable. Structural steel may be used only when it is necessary to support or carry heavy equipment, craneways, etc. Loading racks should be designed with wooden structures and walkways. Bear in mind that the use of steel alone is not fireproof construction.

It is the practice of the War Production Board to assign preference ratings sufficiently high to insure the procurement of materials only when it can be shown that the materials are to be used in a project necessary in the prosecution of the war. In very few instances is the War Production Board authorizing an increase in rating simply because material cannot be procured on the rating that has been assigned.

In making an application for a preference rating for a project as prescribed on Form PD-200 and PD-200a, the instructions should be followed implicitly and completely and each item of material and the value thereof listed in accordance with the form. When several items are lumped together with one value and it becomes necessary to deny or delete certain items, it is then necessary to write to the applicant for the prices of the items denied so that the value of all rated materials may be shown correctly. This delay can be avoided if the applicant adheres strictly to Form PD-200 and PD-200a.

In the designing of projects for which a preference rating is to be applied, engineers should become reconciled to the fact that we are engaged in an all out war requiring scarce materials far in excess of our available supply. Many engineers are designing for long life and with high factors of safety just as they designed before we entered the war, when these scarce materials were abundant. Every feature of design should be studied with the thought in mind of reducing or eliminating the amount of scarce materials to the greatest extent possible. We must become reconciled to a less permanent type of structure even though we may have to replace parts of it at frequent intervals. The War Production Board recognizes that temporary or cheap construction and the absence of standby facilities create certain hazards, but it believes that industry must assume its share of the hazards along with the Army and the Navy.

### Instruments, Regulators, Valve Controls Restricted

In a move to conserve nickel, chromium, and their alloys, the War Production Board has assumed control over the production and distribution of many types of instruments, regulators, and control valves used in general industrial processing and in the manufacture of war material.

Many of these instruments, highly technical in character, are required by war industries. With the assistance of technical personnel of all interested government agencies, and of the industry, WPB's General Industrial Equipment Branch has drafted specifications for the production of various types of instruments and restrictions on their use, which are incorporated in Conservation Order L-134.

The order covers 28 specific items forming component parts of industrial processing instruments and valves and regulators. In certain cases, it restricts the size and maximum chromium and nickel-alloy content of these items. In addition, it limits the use of instruments containing these critical materials to certain specified operating conditions.

The order outlines manufacturing specifications for various types of instrument parts, such as valves, nozzles, protective tubings, thermocouples, sockets, etc., and sets forth the use to which these parts may be put.

### Knowlson to Administer Priorities, Requisitioning

Authority to operate the priorities system and to administer regulations under requisitioning acts was officially vested in James S. Knowlson, Director of the Division of Industry Operations, by Regulations Nos. 1 and 2 of the War Production Board.

These regulations delegate to the Director of Industry Operations the powers conferred upon the chairman of the War Production Board by Executive Order No. 9040. The Executive Order abolished the Office of Production Management and transferred to the chairman of the War Production Board the powers and functions previously exercised by OPM and by the Supply Priorities and Allocations Board.

The authority delegated to the Director of Industry Operations includes power to issue priority orders and regulations; to compel the acceptance of war orders by producers and manufacturers; to requisition the property of any person or firm that is needed for the war effort, in accordance with federal statutes, and to approve requisitions of other federal agencies. The power to ration products at the retail level is, however, reserved to the Office of Price Administration by Directive No. 1 of the chairman of the War Production Board.

### Definite Delivery Date Required on Priority Applications

All applications for priority assistance that do not specify a required delivery date will hereafter be returned to the applicant by the War Production Board, it was announced April 23 by J. S. Knowlson, Director of Industry Operations.

Priorities Regulation No. 1 as Amended requires every applicant for priority assistance to specify in his application the latest date on which the items in connection with which priority assistance is requested can be delivered to him to meet his contract obligations or production schedules. Nevertheless, many applicants, especially those submitting individual applications on PD-1A forms, have been specifying "immediately" or "at once" instead of filling in a definite delivery date. Hereafter, no such applications will be considered until an exact delivery date has been filled in.

### Naphthenates Controlled

Naphthenates and their source material, naphthenic acid, were placed under strict use and allocation control by Order M-142, effective May 5.

### Acrylonitrile Under Allocation

To insure continued full production of Buna N Type oil-resistant synthetic rubber, Acrylonitrile (Vinyl Cyanide) was placed under complete allocation May 14 by the Director of Industry Operations.

The order, M-153, prohibits the delivery or use of Acrylonitrile in any amount except upon specific authorization of the Director of Industry Operations.

The production of Buna N Type synthetic rubber is the sole use for Acrylonitrile, and it is manufactured by only three companies. Synthetic rubber has been under complete allocation since July 1, 1941, so the Chemicals Branch of WPB knows exactly how much Acrylonitrile is produced, and how much is needed.

Supplies of this material are adequate, according to present figures. Allocation of the supply is considered necessary at this time, however, to prevent dislocation of supply and demand because of excessive forward buying, or the accumulation of excessive inventories. Applications should be made for each monthly period, prior to the first of each month. Provision is made in the order for allotment of additional amounts during the month to cover emergency requirements.

### M-34, Toluene Amended

To provide manufacturers of TNT and other war materials with an additional 200,000 gal. of toluene per month, an amendment to General Preference Order M-34 was issued May 22 by the Director of Industry Operations.

The amendment directs every person who cokes coal or processes oil to operate his plant so that the maximum amount of toluene will be produced. Every such person is forbidden to sell, ase, or deliver any oils containing toluene until the maximum amount of toluene has been extracted or unless the purchaser is equipped to extract the toluene himself. Oils from petroleum sources are not affected. "Oils," for the purposes of this order, means drip oil from the gas industry, and light oil produced in coal coking.

### Naphthalene Under Allocation

Distribution of naphthalene was placed under rigid allocation control beginning June 1, by the terms of Conservation Order M-105, issued May 6 by WPB.

After that date, except for certain exempted types of delivery, all naphthalene shipped by a producer or distributor must be delivered in accordance with schedules to be issued by the Director of Industry Operations at the beginning of each calendar month.

Deliveries that may be made without specific authorization will include the following:

(1) Deliveries of naphthalene solely for the purpose of refining.

(2) Deliveries to persons who will refine the naphthalene but will not consume the entire amount delivered in further processing or manufacturing into another product, after refining.

(3) Deliveries up to 250 lb. to any one person in any one month, provided the receiver does not receive during the month, from all sources, more than this amount, and that the aggregate of all deliveries by a producer or distributor under this exemption does not exceed 2 percent of his production.

(4) Deliveries of oils containing less than 25 percent naphthalene. (Delivery of such oils may not be made if they are for concentration of the naphthalene content to more than 25 percent.)

### Asked to Obtain Petroleum From Nearest Source

The Office of Petroleum Co-ordinator Harold L. Ickes has urged oil suppliers to increase further the movement of tank cars in East Coast service by obtaining their stocks from available supplies nearest to the point of use.

An amendment to a formal recommendation (No. 12 of the Co-ordinator) calls upon suppliers who import petroleum and petroleum products into District 1—the East Coast States—to fill their requirements by shipping the oil or products "from that point where there is available a supply . . . which involves the shortest railroad haul."

Deputy Co-ordinator Ralph K. Davies stated that the recommendation will enable suppliers to reduce the number of long hauls made by tank cars bringing oil or petroleum products into the 17 East Coast States and the District of Columbia.

"By going to the nearest source of supply," Davies said, "companies will reduce the average number of miles that tank cars travel in East Coast service and, thereby, will increase the number of round trips that tank cars can make."

### Increase in Crude Price for Houston Oil Company

A maximum price of $1.30 per bbl. for East Texas crude petroleum sold by the Houston Oil Company of Texas at its Tank No. 11, Peterson Tank Farm, Isaac Ruddle Survey, Rusk County, Texas, was permitted May 26 by OPA in an amendment to its petroleum and petroleum products price schedule.

The amendment (Amendment No. 16 to Revised Price Schedule No. 88, Petroleum and Petroleum Products) is effective February 2, 1942.

All of this product is bought under contract by Shell Oil Company, Inc.

On October 8, last, the companies involved renewed a contract made October 30, 1940, providing for the Houston Oil Company to sell its entire product at a gathering point in the East Texas field at a price that was to be the sum of the posted price for the pool, plus 5 cents per bbl.

Provisions of Revised Price Schedule No. 88 made necessary a reduction in the agreed-on price of 2½ cents per bbl.

Both petitioners declared the price established under the schedule was subnormal when competitive conditions are considered and asked to restore the contract price for transactions covered by the contract.

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# MORE oil with LESS steel is today's EMERGENCY!

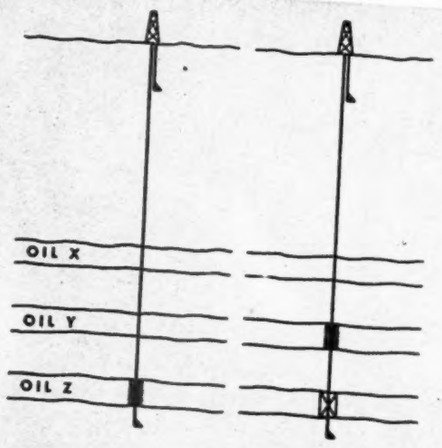
Every oil producer knows that demands for crude oil and its products will continue to mount despite the sharp curtailment of steel for the drilling of new wells. Production cannot be economically maintained or increased simply by "opening valves." Oil well operators must maintain uninterrupted production and they must continue to produce *more* oil with *less* steel.

Lane-Wells Gun Perforator Service makes it possible to open secondary producing zones and increase the production of existing wells. Radioactivity Well Logging can find potential horizons cased-off in older wells.

Lane-Wells engineers and field men know local conditions from long experience. They are on call 24 hours a day to give you Service.

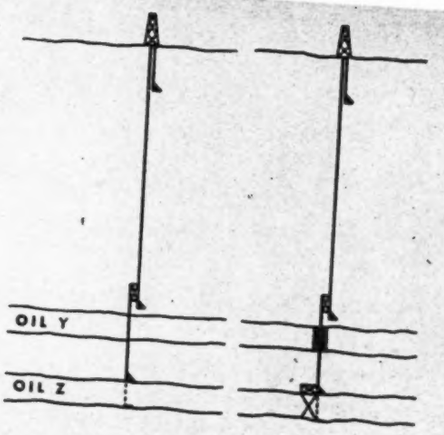
Check these three Lane-Wells Gun Perforator applications against your own production problems. You'll agree with more than 3100 oil companies that it pays to "Call Lane-Wells".

## These 3 LANE-WELLS GUN PERFORATOR APPLICATIONS ASSURE UNINTERRUPTED PRODUCTION



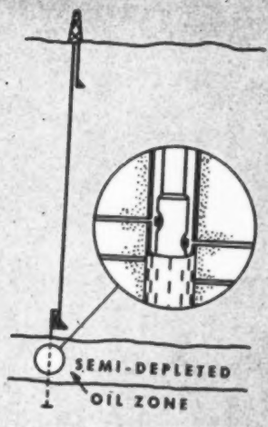

### SELECTIVE COMPLETION

Drill and cement casing straight through the lowest producing sand. From accurate Electrolog records producing zones are located. Gun Perforation of the casing permits production of individual zones. As each zone is exhausted a bridging plug is run and the next higher zone is gun perforated for production. Selective completion allows for greatest production of well at lowest cost.




### PLUG-BACK OPERATIONS

Many wells classed as off production have really passed through profitable sands cased off on the way down. A Radioactivity Log accurately locates potential horizons through casing. Gun Perforate these zones for production. Plug-back operations alone have increased immeasurably the nation's reserves of previously unrecoverable oil.




### SEMI-DEPLETED ZONES

Low production is often due to clogged screens or liners. Gun Perforating reopens old perforations and provides new drainage channels to restore normal production. For acid treatment the perforator projectile makes a funnel-shaped opening in sand or limestone formation which is completely filled with cracks and fractures providing a substantial increase in exposed area.

## "call Lane-Wells and KEEP 'EM FLOWING"

LANE-WELLS Everywhere

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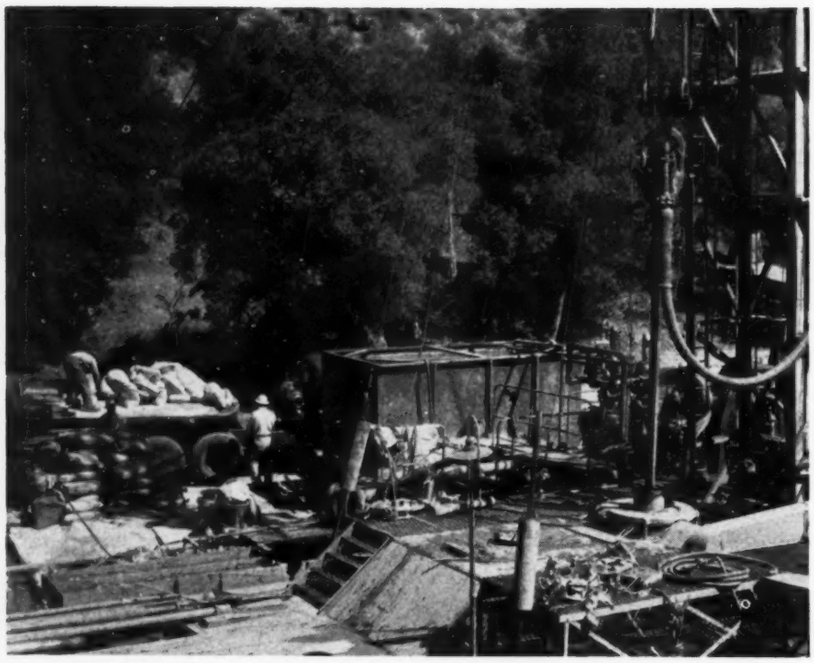


*Showing the arrangement for handling mud at a portable rig*

PETROLEUM ENGINEER Exclusive Feature

*by Wallace A. Sawdon*
Pacific Coast and Foreign Editor

# Mud Control of Vital Importance to Drilling Technique

## ☆ Portable mud-testing laboratory an advanced method of assuring proper conditioning

ALTHOUGH the important part that mud fluid plays in modern rotary drilling technique is generally recognized, the true importance of mud control is not universally appreciated. The amount of conditioning necessary during the drilling of a well is governed by the conditions encountered; but greater attention is continually being paid to better control and to keeping the mud fluid within small limits of variation. Equipment for testing must be available at the well if satisfactory mud control is to be obtained and many companies utilize the periodic test service provided by test cars. Some of the larger operators have laboratories centrally situated and well-equipped service cars. One of the most advanced methods for mud control, however, is a portable mud-testing laboratory recently designed by Continental Oil Company and now in service in California.

In addition to affording facilities for accurate testing and greater convenience in making the tests, this laboratory provides for the storing of records, thus making them always available for reference and for aid in determining the mud fluid to use when returning to a field for operations at a later date. The laboratory is of welded-steel construction, mounted on skids and is transported from one location to another on a truck. Conforming to the exigency of the times, it is painted a dull gray and the windows are blacked out. At the rear of the building are shelves for the storage of cores.

Water and electric connections provide for the necessary operating facilities, which include a double sink and electric stove. The laboratory was designed by men experienced in mud testing and offers all conveniences for laboratory work. At one corner is a desk and in another a filing cabinet. Closet space is provided for the apparatus used in testing and the laboratory and its equipment can be moved without damage to the instruments. The interior is easily kept clean and can be readily washed-down.

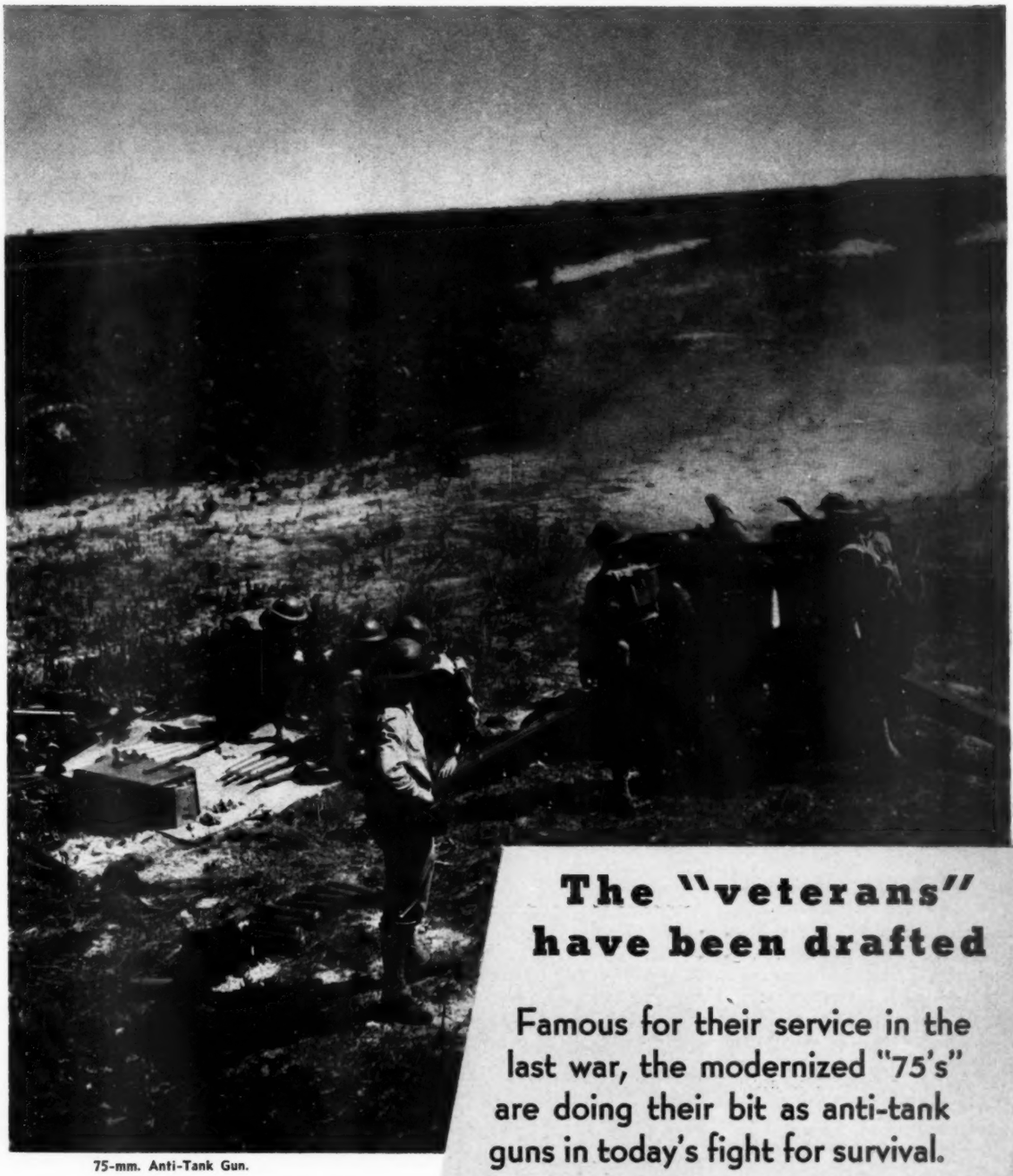
### Testing Apparatus

The apparatus includes a filter press for determination of wall-building qualities and water loss, a pH meter, mud balance and hydrometers, screens for cuttings and sand content, electric mixer, Marsh funnel, triple balance beam scales, a shearometer, and equipment for analyzing for salt content.

The electric stove affords a means of testing viscosity, weight, gel strength, and water loss under various temperatures. New mud is frequently tested at temperatures as high as 170°F., as mud that reacts normally at atmospheric temperature may give a different reaction at hole temperature. The reactions obtained at various temperatures used in preliminary tests indicate what may be expected and further tests made when the fluid is in circulation are performed at actual return temperatures. The mud during circulation does not attain bottom-hole formation temperature and, although there may be some heat loss before it reaches the surface, the temperature at the return is usually very close to that of the fluid itself when it is at the bottom of the hole, making routine tests performed at return temperature sufficiently accurate.

### Testing Procedure

The procedure followed at the well

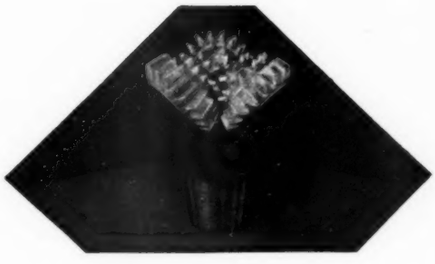


75-mm. Anti-Tank Gun.

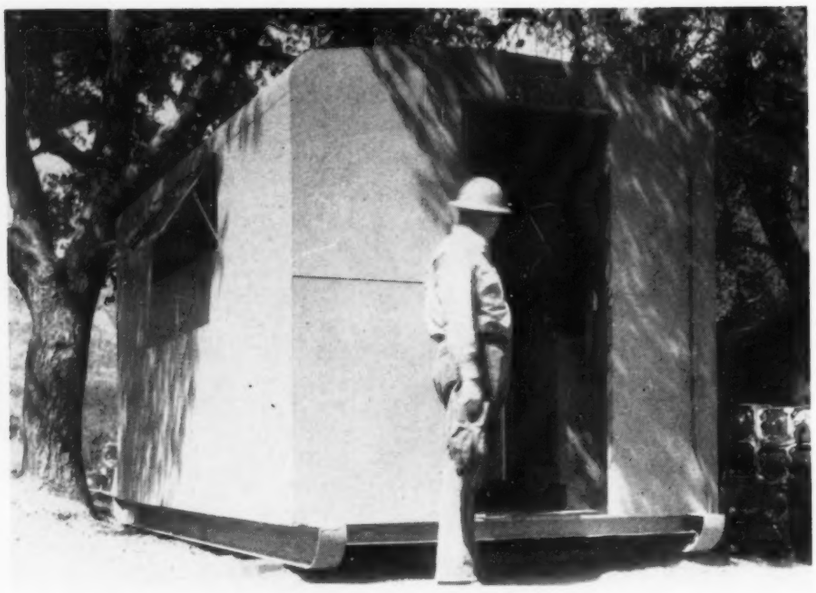
## The "veterans" have been drafted

Famous for their service in the last war, the modernized "75's" are doing their bit as anti-tank guns in today's fight for survival.

Famous for years as "bits of speed and economy," Hughes Rock Bits are doing their bit today in producing the oil which "keeps 'em firing."



# Hughes Tool Co., Houston, Texas



*Continental Oil Company's portable mud laboratory*

where the laboratory is now in service requires the taking of samples at stated intervals for routine tests. When the test indicates that chemicals should be added, allowances are made from the test data before using, as there are many factors encountered while drilling that may have an influence on the mud fluid. Approximately one-half the amount of chemical is added initially and another sample is taken at the end of the circulating cycle to determine what the effect of the chemical has been under down-hole conditions.

Tests are also made on the treated mud as it goes into the hole. The sample for this is taken just above the pump suction as it is important to know exactly what is going into the system. Upon return of the treated mud another sample is taken and whatever further treatment is necessary is indicated by this test.

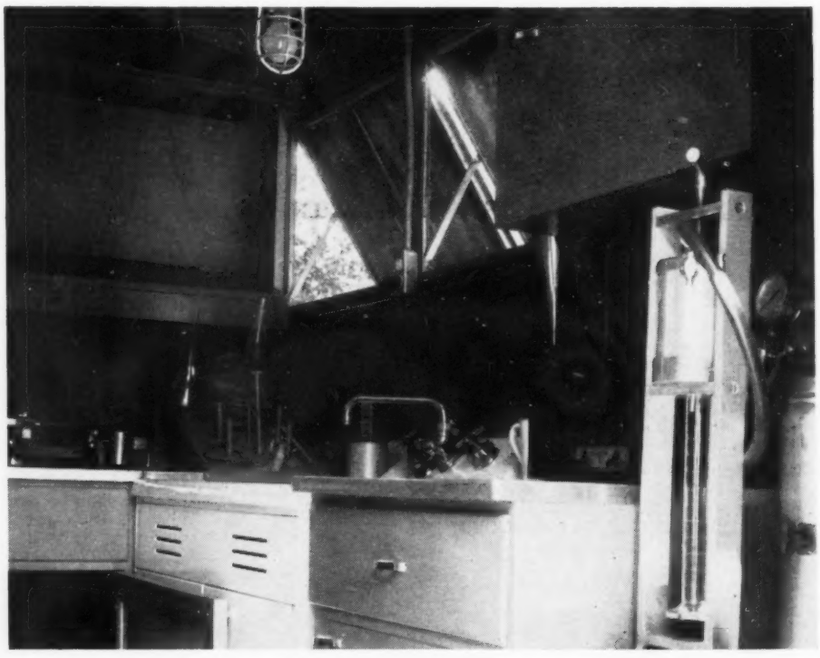
Certain conditions obviously increase the importance of different tests. The gel strength, as determined by the shearometer, is, for example, particularly important when drilling in sand because sand tends to settle out unless kept in suspension. The sand will give weight to the fluid if it can be kept in suspension, but it must be remembered that it will have abrasive action on the pumps and tubing. Sand is an inert material and its presence will affect the thixotropy (gelling property) as well as the other characteristics of the fluid. The kind and fineness of the sand, as well as the amount, will influence its control. Some de-sanding equipment is necessary when the quantity is too great to be handled by the settling ditches or is too fine for retention by a vibrating screen. High gel strength will retard settling in the ditches so careful evaluation based on elutriation or other sand content determination being employed must govern the conditioning of the mud fluid when sand is getting into the circulating system.

The control of viscosity assumes added importance when gas is entering the mud stream. Whether degassers are necessary or the ditch is capable of eliminating the amount of gas being produced, the viscosity of the fluid must be maintained sufficiently low to let the gas out.

More and more attention is now being paid to the mud being circulated during completion operations. When drilling through a porous formation with a differential pressure on the sand there will be a water loss and mud cake will form on the face of the sand. Proper conditioning of the circulating fluid will cause the filter cake to form rapidly with little loss of water, the cake becoming effective while still thin. In addition, it is easily removed. Further building up of the filter cake is then prevented by the effective cake already formed on the wall, which prevents more water from leaving the fluid. As this requires proper colloidal properties in the drilling fluid, any deficiency indicated by the filter press can be corrected by the addition of colloidal material.

Weight requirements are governed by the pressures encountered, but control of mud fluid necessitates more than the mere addition of weight material when high-pressure formations are penetrated. With proper facilities for testing, the drilling fluid can frequently be kept effective for pressure control at weights appreciably less than those found necessary when conditioning based on adequate tests is not employed. The formations penetrated during the drilling of a well may change the properties of the mud;

*All facilities are provided for mud control in this portable laboratory*



PETROLEUM ENGINEER EDITION

# BAASH ROSS News

BAASH-ROSS TOOL COMPANY, LOS ANGELES, HOUSTON, NEW YORK

A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

Conservation means not only doing longer with what you *have*, but being doubly careful in what you BUY. For it takes no more alloy steel to make a *good* Drill Collar than it does to make a *poor* one. Yet the difference in performance and long life—both per dollar invested and per pound of steel used—is tremendous. So to conserve *your* equipment dollar, *as well as the nation's steel*, make sure you know what to look for when purchasing large alloy steel products such as drill collars . . .

# A TIMELY YARDSTICK for judging drill collar purchases

## How You Can Help Your Company Get Better Equipment . . . Help Your Government Conserve Steel

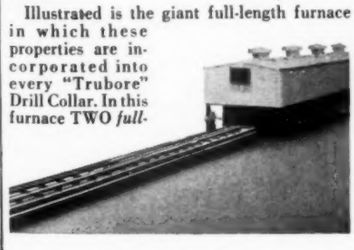
**TODAY, as never before, oil men contemplating the purchase of new drill collars should study the problem with the greatest of care. For a lot of high grade alloy steel goes into a drill collar and it takes no more metal to do the job *right* than it does to do a halfway job. To assist operators in knowing the essential points to look for in a drill collar, here are the features that have made Baash-Ross Drill Collars famous throughout the oil industry for their long life, smooth operation and high all-around efficiency.**

**BALANCED DESIGN:** Remember that a drill collar has several jobs to do, each requiring different properties in the steel. It must have a hard surface to resist abrasion against the raw fresh-cut walls of the hole. Yet it must be tough to withstand the constant jarring, twisting impact strains of rotating the bit. And it must be strong to hold together under the heavy strains of pulling through tight spots, key seats, etc.

Now any metallurgist can tell you that hardness and toughness are two difficult things to combine in *one* piece of metal. If the metal is too hard, then it becomes brittle. If it's too tough, hardness is reduced.

Through years of specialization, Baash-Ross has learned exactly how to select the alloy steel and heat treat it to produce . . . not necessarily the *hardest*—nor the *toughest*—nor the *strongest* drill collar . . . but rather, the drill collar that has *all* the required physical properties—hardness, toughness, strength, resistance to fatigue, impact, etc.—in the best *balance* for maximum service and performance. This all-around balance is a difficult property to *see* in a drill collar, but when you specify "Trubore" Drill Collars, you can be sure it's there!

Illustrated is the giant full-length furnace in which these properties are incorporated into every "Trubore" Drill Collar. In this furnace TWO *full-length* heat treatments are given each collar to produce the most desirable combination of physical properties throughout the length of the forging, and to assure freedom from residual strains. Then the ends are further heated, quenched in oil and drawn to a hardness of 285-310 Brinell, with the hardness individually checked on each threaded connection!



*View of full length heat treating furnace*

*Brinell-testing the ends*

**STRAIGHT BORE HOLE:** Machining the circulation hole in a drill collar is one of the most exacting jobs imaginable. This hole is bored from each end to meet in the middle. If the holes don't meet exactly, a "dog-leg" is left at the center. This is not only sufficient, in itself, to make the drill collar run unevenly, but the trouble gets worse with use. This "dog-leg" causes turbulence in the flow of the drilling fluid, setting up "eddy currents" that eat out and enlarge the hole at this point—throwing the collar—and with it, the drill string—into a bad state of the "jitters." Not only that, but did you ever try to get a retractable core barrel or survey instrument through a doglegged drill collar? Try it!

You'll never find this trouble in Baash-Ross "Trubore" Collars. The circulation hole is held to tolerances so close that special boring equipment has been developed to meet them. And then the hole is *double-checked*—first—by passing a ten foot test bar, not more than ⅛" smaller than the bore, through from end to end. It must pass freely at all points *without binding!* Then the bore is again checked by

*Bore accuracy is carefully checked to insure uniform wall thickness*

surveying the hole, end to end, with the precision survey device illustrated. To pass this test the bore must be so accurately centered that the wall thickness does not deviate from the theoretical correct more than plus or minus ¼" in 40 feet, $\frac{5}{16}$" in 50 feet, or ⅜" in 60 feet!

**EXACT JOINT ALIGNMENT:** There's no chance for wobbly joints or severe pin stresses in "Trubore" Drill Collars because *each individual joint* is carefully surveyed for accurate alignment. The projected axes, with respect to the nominal axis of the collar, do not deviate more than ½" in 40 *feet. That's an angle of less than 6/100 of 1 degree—almost perfect!*

*Exact joint alignment is assured by precision survey equipment*

**STRAIGHT END-TO-END:** Added to precision joint alignment and the accurately drilled bore hole, the over-all straightness of Baash-Ross Drill Collars is held to within ¼" of true *over the entire length* to insure a straight, true-running collar at every drilling speed.

**These are only four of the many qualifications painstakingly built into *every* "Trubore" Collar by Baash-Ross precision workmanship. But they are typical of the precautions Baash-Ross takes to do the job *right* . . . to put in top performance per dollar—top performance *per pound of steel used!***

**Why not specify "Trubore" Drill Collars next time you order. They're available in all popular sizes and types, and your nearest Baash-Ross representative will be glad to supply full details. Or write direct!**

### It's *still* the little things that count!

If you've been wondering why Government conservation orders are effecting some apparently insignificant items in daily use, here are some interesting facts that shed considerable light . . .

**JUST SIXTY** of those collapsible shaving cream and toothpaste tubes you've been asked to turn in have enough salvageable tin to do *all* the soldering and make *all* the electrical connections on a bomber.

**ONE FIGHTER PLANE** could be constructed from the aluminum in 125 of the larger juke boxes . . . and that's a better tune to play right now, anyway.

**FOR EACH** automobile NOT made this year, we save enough tin to coat 1000 cans . . . enough nickel to make 100 pounds of nickel steel for armor plate, projectiles and armor-piercing bullets . . . and enough zinc to make 2400 30-caliber brass cartridge cases.

**A LARGE** electric manufacturing company is reclaiming every possible bit of scrap metal—even in the sweepings from the floor—by means of an elaborate system especially set up. In one month the firm salvaged 120,000 pounds of aluminum and almost a million pounds of other non-ferrous metals.

*Introducing colloidal material into the mud stream*

and the object of mud control is to obtain the best mix for the existing conditions at all times during the drilling of the well.

### Conservation of Casing

In several instances, different companies operating in the San Joaquin Valley, California, recently conserved a string of casing in each of a number of wells by carefully controlling the mud fluid to within small limits of variation. This has resulted not only in drilling economy, but also in releasing, up to the time of writing, more than 1000 tons of steel for war purposes. In some cases the weight of the mud has had to be increased, but in others the same weight mud was used but closer control was exercised.

In one field where production is from depths of 9,000 to 10,000 ft., an 8,200-ft. string of 9-in. casing was eliminated and more than 900 ft. of 6⅝-in. string (usually run to below 9000 ft.) was saved. The weight of the mud circulated during the drilling of this well was from 90 to 92 lb. per cu. ft., which was approximately the same as employed in previously drilled wells. More colloidal material was used, however, and chemicals were introduced to reduce the water loss. Systematic testing was done and after each test the mud fluid was conditioned to maintain predetermined standards within small variations in weight and filtration characteristics. Formations at a certain depth in this field cause loss of circulation and the mud weight necessary to keep shale from sloughing could not be used until additional colloidal material and another admixture for preventing loss of circulation were added in amounts requisite for proper control.

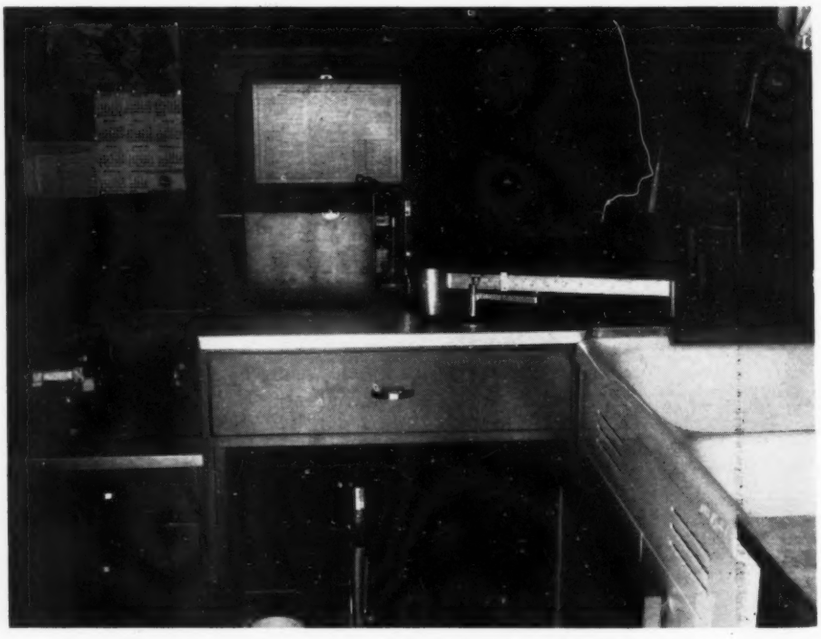
In another field where completions have been at a depth of approximately 6500 ft., a 5600-ft. string of 11¾-in. casing has been conserved in four recently-drilled wells by increasing the weight of the mud fluid and controlling its other characteristics. The weight of the mud previously used in drilling wells in this area had been 82 lb. per cu. ft. and the 11¾-in casing was run and cemented to case-off a shale bed that tended to cave when this weight mud was employed. By using a 98-lb. per cu. ft. mud the caving was prevented and it was possible to go in and out of the hole without difficulty.

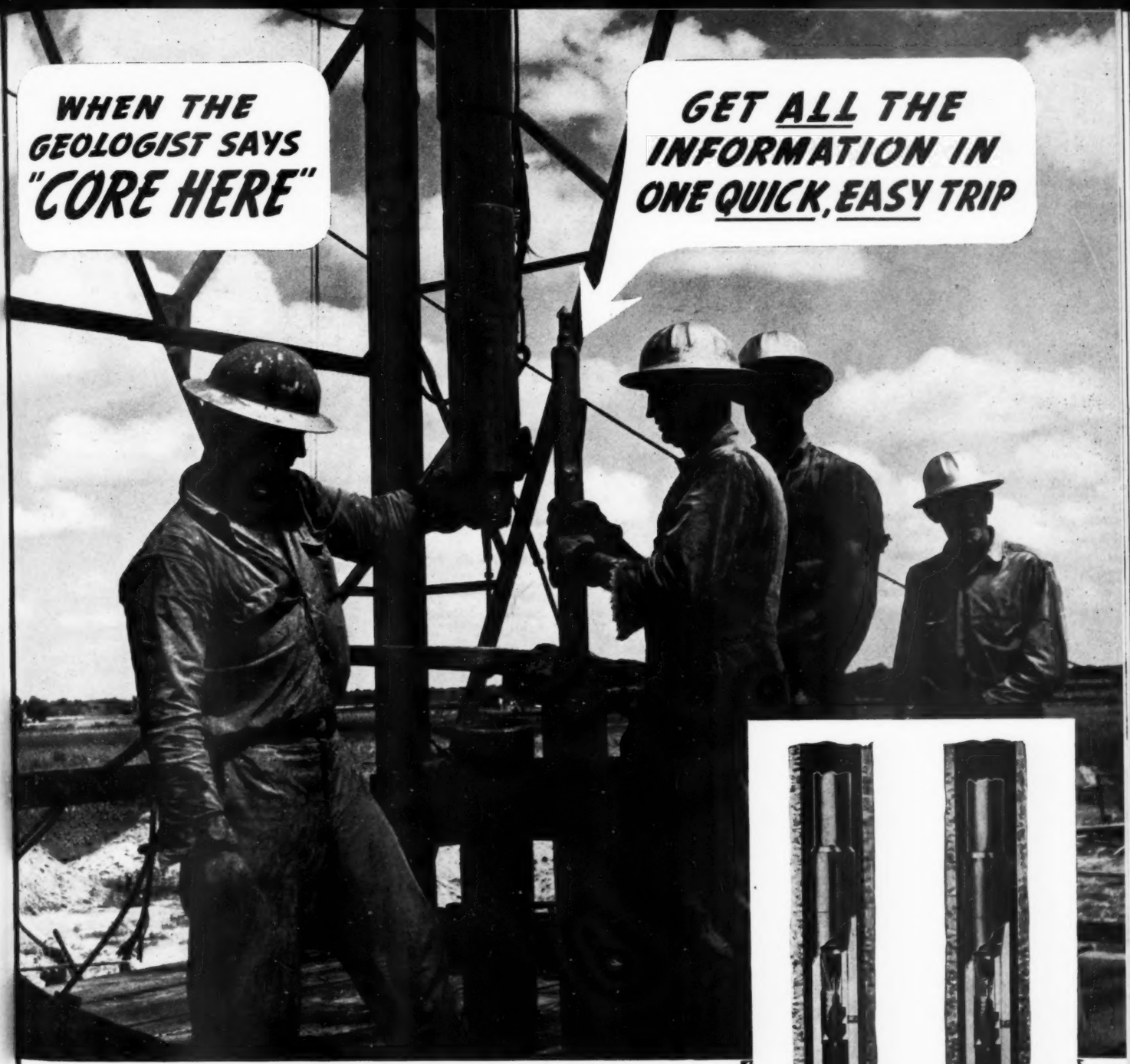
During the drilling of these wells careful mud control was practiced and sufficient colloidal material was added when necessary to keep the water loss at less than 10 cc. as determined by A.P.I. standard tests. At times chemicals were added to decrease the water loss further by keeping the colloidal material dispersed and to control the gel strength and viscosity. The viscosity was maintained below 60 seconds (A.P.I. funnel test) and the gel strength below 25 grams (A.P.I. Stormer viscosimeter test).

The total contribution of mud control to drilling technique is difficult to appraise, as the experience of mud engineers, utilization of testing equipment, development of chemicals and admixtures, and the application of A.P.I. standards have prevented a knowledge of emergencies that have not been allowed to materialize and have facilitated drilling procedure to such an extent that it is hard to realize some of the difficulties that might have arisen if the mud had not been kept in proper condition.

☆ ☆ ☆

*Here can be seen a part of the desk and some of the testing equipment in the portable laboratory*






# THE HUNT SIDE WALL CORING TOOL

***recovers real cores . . . not samples. Cores large enough to be easily and quickly analyzed by leading core laboratories.***

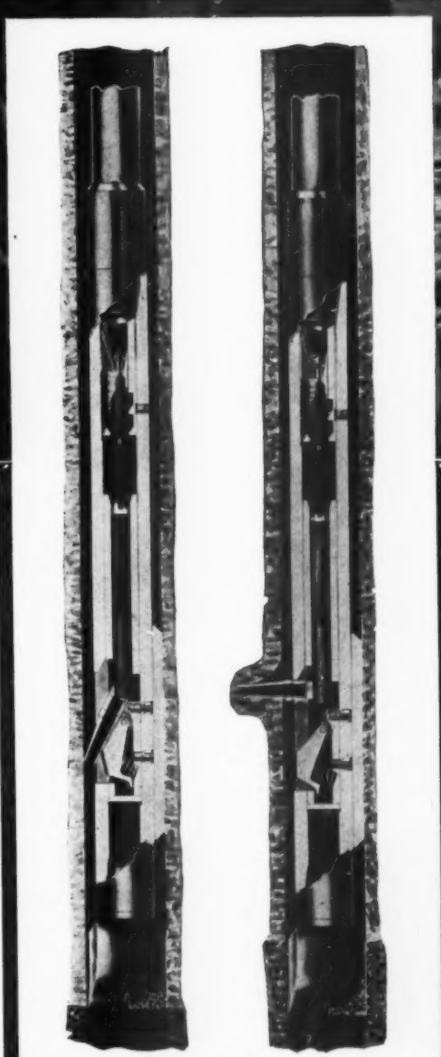
**The Hunt Side Wall Coring Tool,** as its name implies, is designed to recover portions of UN-CORED FORMATIONS from the side wall of a hole. After drilling to any predetermined depth, the well may be electrically logged and side wall cores obtained of all possible producing formations, quickly and at low cost. The Hunt Side Wall Core Barrel is dropped and recovered in the usual wire line manner. No additional equipment is necessary.

**The Hunt Side Wall Coring Tool** recovers real cores, not formation samples. It is designed to recover cores ranging from 1" to 1¾" in diameter and up to six inches in length. Size of the core is governed by the inside diameter of the drill pipe. Write for descriptive literature on this modern, positive method of coring.

HUNT TOOL COMPANY

*Field Shops:* Houston, Bay City, and Corpus Christi, Texas; Jennings, Harvey, and Shreveport, Louisiana.

*Export:* W-K-M Company, 74 Trinity Place, New York City.



Core tube deflected, ready to penetrate side wall to take core.

Core tube in side wall after lowering of drill pipe has caused penetration.

# A Note on Conservation*

## ☆ A plea for avoidance of physical waste both below and above ground

*by E. L. DeGolyer*

Director of Conservation, Office of the Petroleum Coordinator

**E. L. DeGOLYER**

at one time was a member of the U. S. Geological Survey, chief geologist of the Mexican Eagle Oil Company, and organizer of the Amerada Petroleum Corporation—is senior member of DeGolyer-MacNaughton and McGhee, Dallas, Texas—In 1942 received the John Fritz Medal and in past years has been honored with various awards for distinguished work in the finding and producing of oil.

"SIMPLY by abandoning the policy of conservation," a director and economist of one of our leading oil companies is reported in the trade and daily press as assuring us, "this nation's 380,000 oil wells could provide more oil than the whole world produced last year." I can not dispute this conclusion. Doubtless you will agree that more light can be created in this room by setting fire to the furniture than can be achieved by the simple and orderly procedure of turning on the electric lights. I doubt whether either of these striking and compelling facts is of enough importance, however, to preserve it from that limbo of similar trivia, the "believe-it-or-nots."

I regret that I have not yet seen the entire article from which the quotation comes. If, however, any implication is intended that there would be any advantage to the industry or to the nation, except in time of direst emergency, by the abandonment of such advancement in conservation of oil and gas as we have achieved up to the present time, I must disagree emphatically.

I regret that we must use the word conservation to describe what, in my opinion, is simply good engineering practice and good business in the production of oil and gas. It has several unfortunate connotations.

When efforts toward the prevention of waste of the natural resources of our nation first crystallized as a formal movement under the patronage of President Theodore Roosevelt in 1907-08, it was regarded by practical oil men as theoretical and academic. Little was accomplished, insofar as our industry was concerned, except to get for us the first considered estimate of oil reserves and to establish conservation as a dogma for most of the scientific and technical workers in the industry. The conservation movement at this early date had a sort of "save-some-oil-at-any-cost" flavor and was rightfully regarded as impracticable and visionary.

Again, when in the late twenties and early thirties the potential productive capacity of the industry under the old open flow system had become so great that it had become necessary to impose the restrictions of proration, conservation was invoked by the states and by the industry as a sanction for such restriction. There are doubtless still many of you who regard conservation as simply a surplus control and, to put it bluntly, a price fixing racket.

So, with many of you, the term conservation still suffers from the supposed stigma of being impracticable and visionary and that of being a price control.

### Definition of Conservation

Actually, the term conservation has been re-defined within recent years as "wise use" and in the oil industry its field has come to be generally restricted to that of production of oil and gas and to mean the avoidance of physical waste either above or below ground.

Nor can we pass this simple definition without some further consideration of its meaning. Petroleum engineers, within recent time, have referred to waste and unavoidable waste; actually they mean waste and loss. Actually there must always be some substantial loss in the mining of oil and gas. Obviously, 100 percent of the oil originally in place could not be recovered without mining the sand and washing or distilling it and the cost of such operation would exceed the value of the product. As one prominent economist has defined the difference between the two terms "no loss represents a waste unless the cost of avoiding the loss is greater than the cost of submitting to the loss." As phrased by W. S. Farish, with regard to our particular problem, we must produce "the most oil that can be obtained without spending more on the addition to the supply than that addition is worth."

Surely conservation is neither impracticable nor visionary. When I first became director of conservation in the Office of the Petroleum Coördinator, I was addressed by a leading operating executive with the notice that unless something was done to improve production practice in the great East Texas field, millions of barrels of oil would be lost to recovery. Investigation developed the fact that sound engineering opinion held that a continuance of existing production practices might result in a loss to recovery of 200 to 800 million barrels of oil. As a result of the active coöperation of the Railroad Commission of Texas and of the industry, we are in a fair way to avoid this waste. There can be nothing very impracticable or theoretical about saving an amount of oil likely to be greater than the entire proved reserves of an important oil-producing state such as Illinois.

Doubtless proration was instituted as a control on surplus and it would be folly to deny that as such it has had an effect on the price of crude oil. The physical waste that would have resulted, failing such control or some similar type of control, however, is too great for one to contemplate with complacency.

Whatever the motive for the institution of state regulation of oil and gas production, it has given the industry and its engineers their first real opportunity to study the effects of a managed rate of production. They have found that in a managed—restricted if you please—rate of production they have found the most potent of all tools to aid in solving the problem of obtaining maximum ultimate recovery.

We should have recognized much earlier than we did the advantages of a slow, orderly withdrawal of oil from the reservoir. An oil accumulation in many respects resembles the stream ac-

*Delivered at Spring Meeting, Mid-Continent District, Division of Production, A.P.I., Tulsa, Oklahoma, March 27, 1942.

cumulation in a pan of milk, the oil resting on water as cream rests on milk. No farm wife would be so stupid as not to realize that by hasty and violent action, she would fail to recover much of the cream that might be obtained by slow and orderly skimming.

Production in most fields is largely a skimming process. Every geologist knows, that according to any rational and acceptable theory of accumulation, the formation of an oil pool is likely to have been a slow process requiring thousands if not millions of years. Obviously an attempt to produce—to skim—such an accumulation in a few years is violent and disturbing and except for relatively few pools likely to result in great loss in recovery.

## Production Practices

I have recently had occasion to examine the production practice in two fields, Hobbs, New Mexico, and Tinsley, Mississippi. Each field extends over about the same area, approximately 10,000 acres; though because of differences in the thickness of the producing zone, Hobbs was estimated to have about twice the recoverable reserve of Tinsley with both fields produced under good practice. Each field had substantial water drive. Hobbs was produced slowly enough to allow it to be effective and Tinsley at much too rapid a rate to allow the water drive to be effective.

Hobbs had an original bottom-hole pressure of 1550 lb. per sq. in., approximately 263 producing wells, and after approximately 13 years had produced half its reserve with a loss of less than 400 lb. per sq. in. bottom-hole pressure, and 85 percent of its wells were still flowing.

Tinsley had a higher bottom-hole pressure, some 1850-1900 lb. per sq. in., approximately 327 wells, and after less than two and one-half years had produced a probable third of its ultimate recoverable reserves with a loss of more than 1000 lb. per sq. in. bottom-hole pressure and with none of the wells in the main sand still flowing.

Admitting the difficulty of comparing two widely different fields—realizing, indeed, that all oil fields are unique—the disparity in performance of these two important fields is so great that one cannot escape the conclusion that much of the difference is the result of different production practices. I firmly believe that slow and orderly production in the Hobbs field will result in an increase in ultimate recoverable oil of more than 40,000,000 bbl. over what it would have been under old open flow methods, and that in producing Tinsley under effectively old open flow practice has resulted in laying the firm foundation for a loss of approximately 40,000,000 bbl. of oil that would have been recoverable under proper production practices. One cannot escape the conclusion that the nation, the state, the producers, and the royalty owners have suffered great loss because of poor production practice in the Tinsley field.

That restricted rates of production is true conservation, good engineering, good production practice, good business, and common sense, seems to me to be an unescapable conclusion.

We have but made a good beginning in conservation in the oil industry up to the present time. In my opinion, more than half the oil fields in the United States are susceptible to improvement in production practices. As a matter of fact, our reserves are probably not great enough to support our current rate of production under best production practice. Our present proved reserves are of the order of magnitude of 20,000,000,000 bbl. We should have reserves of the order of 30,000,000,000 bbl. to support an annual rate of production of 1,500,000,000 bbl. Actually, therefore, we must concentrate our conservation efforts on the larger pools and on pools in the earlier stages of exploitation—on the newly discovered pools.

One of the greatest and most obvious wastes that we suffer in the entire business of oil and gas production at the present time is in the production of excessive amounts of gas, incidental to the production of oil, and its burning in oil-field flares.

All producible oil contains some gas in solution and it is not possible to produce oil without producing such solution gas. The amount of gas in solution may be so small as to be almost negligible, such as 20 cu. ft. per bbl. for some of the fields of Western Kansas or of the Talco field, Texas, but it generally runs 300 to 800 cu. ft. per bbl., and, as a practical matter, may be considered never to be in excess of 1000 cu. ft. per bbl. It follows, therefore, that whenever more than the solution gas is produced with a barrel of oil, either gas occurring in a free state underground is being allowed to escape or gas is being allowed to escape from solution from oil remaining underground, leaving the robbed oil more viscous and inert and thus less producible. Much of this excess gas is due to improper well completion arising from the necessities of proration. When potential is a part of the proration formula, the producer generally takes in more gas than is necessary from any free gas zone in order to obtain a gas-lift effect and so a maximum potential rating. To complete a well in such a manner as to obtain an X thousand barrel potential rating for a well that, in all probability will never be allowed to produce more than 50 to 100 bbl. per day, is ridiculous. It would be much better engineering practice to complete the well to produce its likely allowable as efficiently as possible.

Most regulatory bodies are too tolerant of high gas-oil ratios. In truth, many regulatory bodies are not even properly informed as to actual gas-oil ratios being produced as most operators do not actually meter the gas but merely make a safe and conventional guess of the required returns. Tolerance of gas-oil ratios of 5000 cu. ft. per bbl., such as is common for the fields of West Texas where the solution gas generally is not more than 700-800 cu. ft. per bbl. should be corrected.

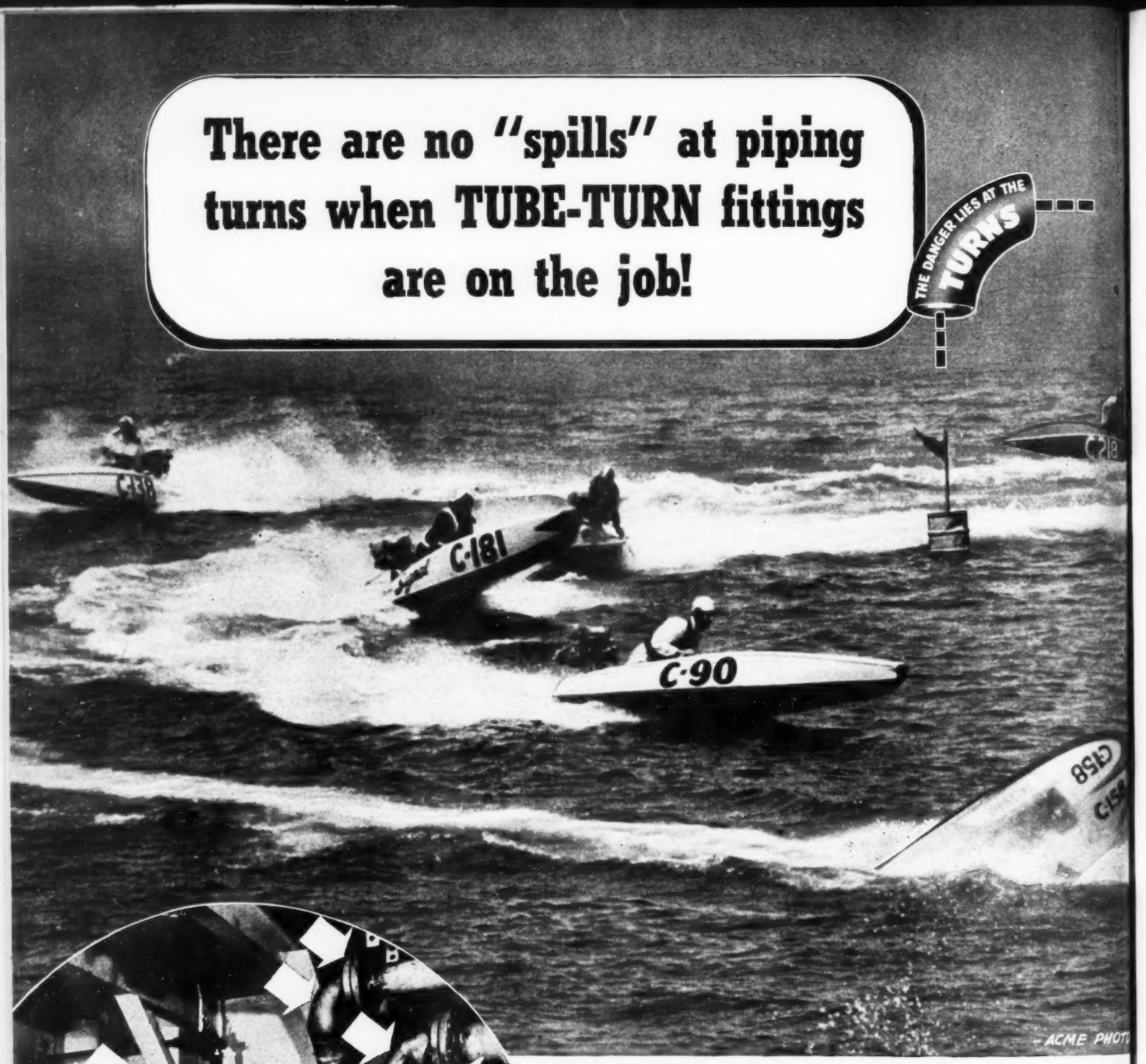
Assuming, however, proper completion of wells with the lowest feasible gas-oil ratio, oil-field gas is still the problem child of the industry. Assuming that it has been processed for the lighter hydrocarbons, many of which have become of such great importance in the war effort, it can only be flared, properly utilized, marketed, or reinjected into some porous formation underground. Its primary use should be to further the production of oil; as the Californians' have well stated it, "to use gas produced in conjunction with the production of crude petroleum primarily for the efficient and economic recovery of crude petroleum." Such use, in most cases, is likely to mean its injection into the formation from which it is produced but, even so, such use is only a transient one and ultimately the gas again becomes available for ordinary markets.

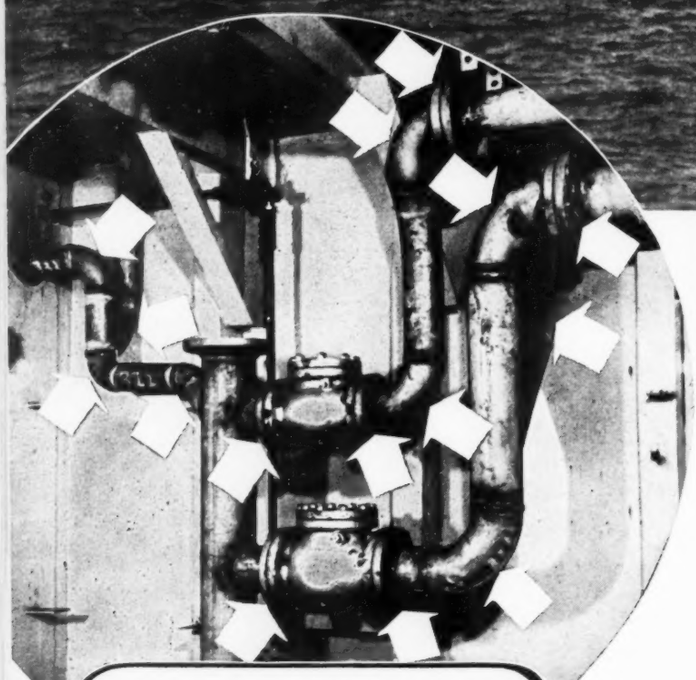
Assuming again that the production of gas has been maintained at a minimum and that it has been properly used to promote "the efficient and economic recovery of crude petroleum," its disposition is still a problem that is solved far too often by burning in oil-field flares.

Gas is coming into its own and it is not at all improbable that in the near future it may become second in importance only to crude oil itself as a mobile energy resource. Gasoline can be made from dry gas—from methane—at prices not greatly beyond those now current. As a practicable matter, gas in small quantities may always be burned in oil-field flares, but undoubtedly the time will come when an enlightened and informed public interest will demand that gas in substantial quantity be properly utilized or stored by reinjecting underground against some future utilization.

—— ☆ ☆ ☆ ——

# There are no "spills" at piping turns when TUBE-TURN fittings are on the job!



In this small area are *fifteen* places where Tube-Turn welding fittings and flanges are on the job—giving full protection against leakage and other maintenance worries. In any complete piping system, figure the hundreds of points where flow direction changes, and you'll see why Tube-Turn returns, elbows, tees, reducers, laterals, nipples, caps and flanges offer extra protection and trouble-free piping.

## Disaster at the turns is an old story—

With spray flying and motors roaring, speed boats hurtle around the buoy-marked racing turns at break-neck speed! Cutting the curves too sharp or too fast means an upset—another case of failure at the turns.

The same danger lies at turns in *piping systems.* Wherever there is a change in flow direction, the strain imposed by the flow speed and pressure increases the probability of leakage and failure unless they're *welded* and *protected* with Tube-Turn welding fittings!

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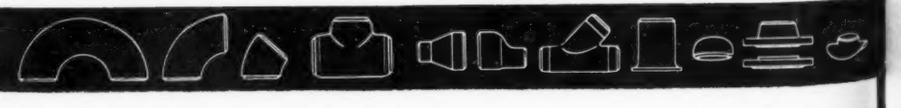


# Basic Considerations of Refinery Pumping

PETROLEUM ENGINEER Exclusive Feature

☆ Study should be made of many factors apart from the pump itself before deciding upon type of pump and the driving unit

*by R. G. Lovell*

Development Engineer, Hancock Oil Company of California

THE most satisfactory answer to a refinery pumping problem is not necessarily to be found in the pump itself. The manner in which the suction and discharge piping is laid may have a profound effect upon the problem. The temperature of the liquid being handled also has a pronounced effect. The temperature affects viscosity, which affects line size, which in turn affects the pumping duty, and the last has the most important effect of all—on the refinery operating cost and facility.

The foregoing effects are closely interrelated but there is another angle that, although not related to the first group, can and does affect the cost and facility of operation. This is the type of power used to drive the pump. This is not a simple matter. For example, a pumping problem can be studied carefully, resulting in a decision to provide certain piping and temperature conditions to make practicable the use of the centrifugal type of pump driven by some logical means such as an induction motor. Suppose, however, a means of controlling accurately the pump discharge must be provided. The induction motor has no variable-speed characteristics and to control the pump discharge rate by strictures in the discharge line is far from satisfactory and can easily cause the waste of much electrical power. A steam turbine then becomes the logical drive, but its cost, added to the cost of bringing piping and temperature conditions to the standards dictated by the centrifugal pump, might be sufficient to outweigh the advantages of the centrifugal. Or perhaps the pressure or quality of the available steam are not adequate to satisfy the turbine. It is easily conceivable that any or all of these factors might constitute reason for foregoing efficiency by a decision to use the direct-acting duplex steam pump. These points are stressed to show how necessary it is to give due consideration to all factors, even those apart from the pump itself, before deciding upon the type of pump or the driving unit.

**R. G. LOVELL**

**received his academic training in New York and served several of the larger mining and milling companies of New Mexico, Arizona, and the Republic of Mexico as power engineer and master mechanic from 1908 to 1917, then saw military service in the engineering corps until 1919—Returning from the war he became affiliated with the oil refining industry, first with Standard Oil Company of California as refinery construction engineer and later with a foreign company—Later he was made assistant to the chief engineer of Pan American Petroleum and Transport Company for the construction of their California processing properties—He has been with The Hancock Oil Company of California since that time.**

It is an entirely reasonable assumption that a reliable pump manufacturer is competent, by reason of experience, to design and build a pumping unit to function under a stated set of conditions. Therefore, the prospective purchaser may well relieve his mind of that part of the responsibility. On the other hand, the manufacturer should not be required, as he so often is, to dictate the conditions under which the unit is expected to operate.

For any purpose of interest to the user of pumping equipment all pumps can be divided into two general classes: centrifugal and positive displacement. Each of these is divided into many types but the sub-divisions are solely to fit conditions of duty and do not bear on the fundamental theory of design and operation.

## Centrifugal Pump Operation

A simple, but entirely complete, definition of a centrifugal pump is one that operates by virtue of imparting velocity to the liquid. This simple definition does not cover a multi-stage centrifugal pump. This must be borne in mind and at the proper time the definition shall be justified.

Roughly, the theory of a centrifugal pump may be illustrated by the old "boy and bucket" simile. The boy whirls the bucket of water about his head and not a drop is spilled provided he keeps the bucket moving fast enough. The force that holds the water against the bottom of the bucket and prevents spilling is called centrifugal force.

Now, suppose a hole is punched in the bottom of the bucket. A stream will flow out with a force that will be governed by the speed with which the bucket is traveling and this speed will depend upon the length of the boy's arm as well as the number of times per minute his body turns. The stream would be continuous if the boy's arm were a pipe supplying water to the bucket. The boy's arm is the suction line and the bucket is an impeller of a centrifugal pump. The casing of the pump is introduced to guide the stream in one particular direction to the discharge outlet.

Suppose now there is a body—say a can of water—on top of a building 120 ft. from the ground. Pushed off, it would fall to the ground at an accelerating speed, finally striking the earth when it was falling with a velocity dependent upon the distance through which it had fallen. The weight of the can of water would have nothing to do with this velocity. We will assume for the moment that it was moving at a speed of 5274 ft. per min. when it landed and proceed with the explanation of the theory.

*(Continued on Page 64)*

# *Two Big Reasons Why* WAR *makes this the*

## *FOR YOU* — 3 TIMES FASTER COOLING TOWER DELIVERY

## *FOR THE NATION* — COUNTLESS MAN-HOURS AND TONS OF CRITICAL MATERIALS SAVED

**A Statement of Fact Concerning Cooling Towers Made as a Contribution to Increasing War Production in Your Plant and to Benefit the Nation's War Effort. This is Why Atmospheric Cooling Towers Should Be Specified Today!**

FLUOR manufactures Mechanical Draft *and* Aerator Atmospheric Type Cooling Towers. We hold no brief for *either* type, recognizing only the fact that each has its own well-defined field of application. Full recognition of these well-defined fields is *vital to Victory!* In this interest, these facts are published.

In recent years, a pronounced and largely "fashionable" trend has developed toward Mechanical Draft Cooling Towers. Demonstrable facts adequately support the statement that *in approximately 75% of the cases where Mechanical Draft types are being installed, Atmospheric Cooling Towers will render identical service with identical thermal efficiencies!* Beyond pointing out these facts, Fluor previously held no brief against this trend, but this is *WAR!* The saving of critical materials, man-hours, machine-hours, power and energy are now definite deposits to the account of Victory!

Read carefully the comparative table of savings on the opposite page. When Atmospheric Cooling Towers are specified, in the cases where they are the *correct* rather than the "fashionable" specification, tons of strategic materials will be released for offensive War. You will save a large percentage of the prime labor required for assembly of your tower, as well as secondary labor used in the manufacture of fans, gears, motors, switches, flexible couplings and electric wiring in addition to the materials from which they are made. In tower operation, you will save and conserve electric power. The sum total of the material, man-hours, machine-hours, power and energy saved constitutes a substantial contribution to the offensive War effort—*without the slightest concession in Cooling Tower efficiency!*

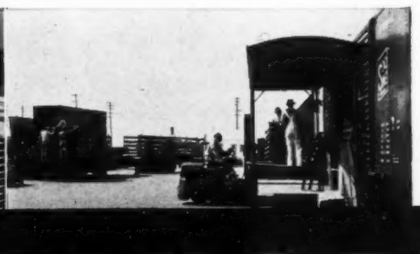
### When to Specify Atmospheric Cooling Towers

This is the rule for *correct* rather than "fashionable" Cooling Tower specification: *Atmospheric Cooling Towers should be specified in all instances excepting those where restricted space or subnormal wind conditions make the use of Mechanical Draft types imperative!* Our engineers will assist, basing their recommendations not on bias but on fact with tower efficiency as the sole objective.

### Why Fluor Atmospheric Deliveries Are Three Times Faster

*Delivery of Fluor Atmospheric Cooling Towers is three times faster!* In the majority of instances, Fluor today is delivering Aerator Atmospheric Cooling Towers ready for fast erection *before our customers have completed foundation basins!* This is due not only to the fact that there is no delay waiting for fans, gears, motors, etc. It is due to Fluor standardization of Cooling Tower Design which makes 100% prefabrication possible. Only Fluor completely prefabricates in a mill with lumber flowing constantly down a production line to finished section storage and thence direct to you. There is no lost time; no waste motion. Your order is filled promptly direct from prefabricated Cooling Tower Section stocks.

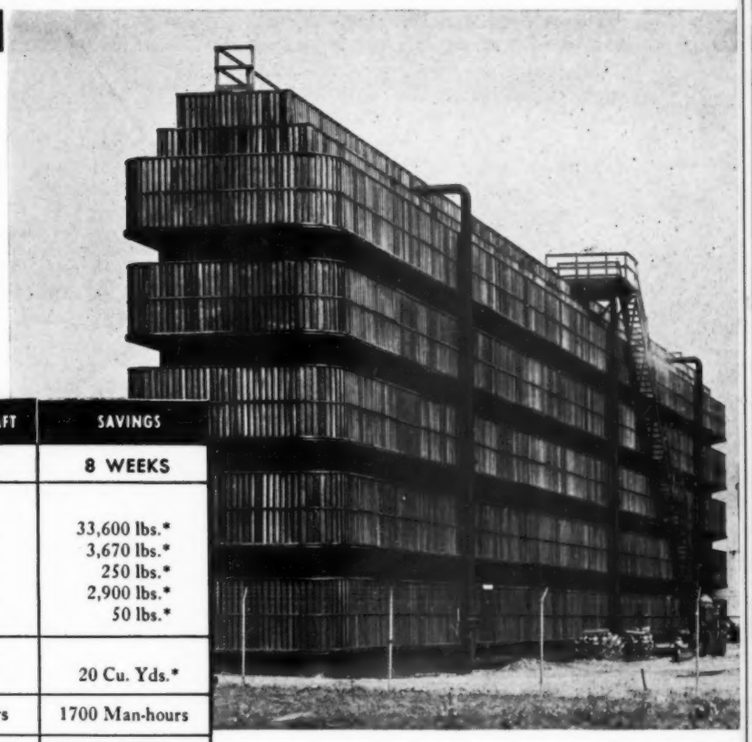
For speed in erection, Fluor-trained erection crews are maintained near your plant. Upon completion of the basin, they are ready to swing into action and your tower is in operation in the shortest possible time—another advantage of Fluor prefabrication and standardization. Before you specify a Cooling Tower, consult our engineers and—*Be Sure With Fluor!*



These views show Prefabrication in our Mill, a Portion of Prefabricated Stock ready for Shipment from Storage and Shipment of Fluor Aerator Atmospheric Cooling Towers by Rail and Truck direct from Stock for Fast Field Erection by Fluor-Trained Crews Stationed in all parts of the Country.

**FLUOR**

# *Day of the Atmospheric Cooling Tower . . .*



**Here Are the Figures (Towers of Identical Capacity)**

*Here is the parallel showing the important savings gained by Specification of Fluor Atmospheric Cooling Towers. This tabulation is for Cooling Towers of identical capacities, in this instance 10,000 G.P.M. Savings for larger or smaller Atmospheric Cooling Towers are proportionate.*

| ITEM | ATMOSPHERIC | MECHANICAL DRAFT | SAVINGS |
|---|---|---|---|
| DELIVERY | 4 WEEKS | 12 WEEKS | 8 WEEKS |
| Critical Materials: | | | |
| 1. Steel | None | 33,600 lbs. | 33,600 lbs.* |
| 2. Fan Material | None | 3,670 lbs. | 3,670 lbs.* |
| 3. Bakelite | None | 250 lbs. | 250 lbs.* |
| 4. Brass | 7,750 lbs. | 10,650 lbs. | 2,900 lbs.* |
| 5. Cast Iron | 19,550 lbs. | 19,600 lbs. | 50 lbs.* |
| Concrete and Steel Reinforcing for Basin | 110 Cu. Yds. | 130 Cu. Yds. | 20 Cu. Yds.* |
| Erection Man-hours | 3300 Man-hours | 5000 Man-hours | 1700 Man-hours |
| Total Fan Horsepower | None | 240 H. P. | 240 H. P.* |
| Electric Motors | None | 7 or more | 7 or more* |
| Electric Switches | None | 8 or more | 8 or more* |
| Reduction Gears | None | 7 or more | 7 or more* |
| Electric Wiring | None | As required | 100%* |
| Conduit | None | As required | 100%* |
| Fans | None | 7 or more | 7 or more* |
| Flexible Couplings | None | 14 or more | 14 or more* |
| Fan Guards | None | 7 or more | 7 or more* |
| Fan Supports | None | 7 or more | 7 or more* |
| Steel Fan Rings | None | 7 or more | 7 or more* |
| Electric Power | Pumping | Pumping Plus Fans | 50% |

**Also saved are man and machine hours in producing raw materials, fabricating and assembling this equipment.*

Before you specify any type of Cooling Tower, you are entitled to the benefit of our experience. Our engineers will be glad to consider your specific requirements and conditions as the basis for calculations, design and cost. Because Fluor manufactures both Aerator Atmospheric Type and Mechanical Draft Types, Fluor recommendations are made without bias or prejudice as to type. Your continued and complete satisfaction is the prime objective.

**FLUOR AERATOR FEATURE MINIMIZES WIND-BLOWN SPRAY**

Due to the exclusive, patented Fluor Aerator feature, water loss due to windage is comparable with that of the best designed Mechanical Draft Types. The Aerator feature consists of two or more baffles interspersed with battens at right angles. Thus, before leaving the tower, air is forced to change its direction, coming in intimate contact with baffles to deposit water held in suspension thereon.

Fluor Cooling Towers are built of California Redwood—noted for its everlasting durability and resistance to heat, cold and moisture. In every feature—design, dimensions, materials, construction—Fluor is the specification of those who want the best. When considering installation of a Cooling Tower, remember this: A good rule to follow is—*Be Sure With Fluor!*

*Get the facts about Fluor Atmospheric Cooling Towers by writing for Bulletin T-337. Your request, mailed today, will bring prompt response.*

**THE FLUOR CORPORATION LTD.**

2500 South Atlantic Boulevard, Los Angeles, California

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# COOLING TOWERS

*(Continued from Page 61)*

Suppose the same can of water could be thrown from the ground to its original position on top of the building. In order for the can to reach this elevation of 120 ft. it must be started with an initial velocity equal to the speed it had attained at the moment of striking the ground in its fall, that is 5274 ft. per min. The formula for the velocity of a falling body is:

$V^2 = 2\,gh$

Where:

V = velocity of the moving body in ft. per sec.,

g = acceleration due to gravity—32.2 ft. per sec. per sec.

h = head in ft., or distance through which object falls.

Substituting the values used in the example:

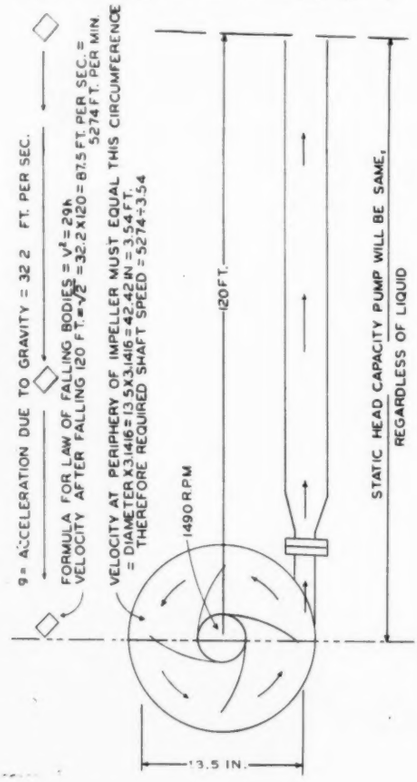
$V^2 = 2 \times 32.2 \times 120 = 7728$

$V = \sqrt{7728} = 87.9$ ft. per sec.

$87.9 \times 60 = 5274$ ft. per min.

It is this law or formula that is used to determine the speed of the periphery of the impeller of a centrifugal pump. The liquid, as it leaves the impeller to be thrown against a given resistance, must have the same velocity as it would if it fell from a height equivalent to that of a column of water high enough to exert a pressure, at its base, of the number of lb. per sq. in. represented by the reading of the pressure gauge at the pump discharge. This rule is basic. It should be remembered that the specific gravity (weight) of the liquid does not enter into the problem. A graphic illustration is shown in Fig. 1. It may be seen that with the same conditions of head, the smaller the diameter of the impeller the greater must be the speed of the pump shaft and vice versa.

*Fig. 1. Theory of the centrifugal pump*


g = ACCELERATION DUE TO GRAVITY = 32.2 FT. PER SEC.
FORMULA FOR LAW OF FALLING BODIES = $V^2 = 2gh$
VELOCITY AFTER FALLING 120 FT. = $\sqrt{2} = 32.2 \times 120 = 87.5$ FT. PER SEC. = 5274 FT. PER MIN.
VELOCITY AT PERIPHERY OF IMPELLER MUST EQUAL THIS CIRCUMFERENCE
= DIAMETER X 3.1416 = 13.5 X 3.1416 = 42.42 IN. = 3.54 FT.
THEREFORE REQUIRED SHAFT SPEED = 5274 ÷ 3.54
1490 R.P.M.
120 FT.
STATIC HEAD CAPACITY PUMP WILL BE SAME, REGARDLESS OF LIQUID
13.5 IN.

## Theoretical Capacities

As yet nothing has been said about the amount of liquid the pump will discharge. The top capacity of the pump depends upon the size of its openings, suction and discharge, and upon the size of the casing. Also, it depends on the width of the vanes of the impeller just as the larger the hole punched in the bottom of the bucket the more water is discharged. The shape of the vanes also has a bearing on capacity but its effect is largely governed by the viscosity of the liquid being pumped.

The pump is allowed by some of these features of design to pass only an amount of liquid that will not cause undue frictional losses due to high velocity. The designer selects the correct size of casing and determines the inlet and outlet sizes in much the same manner as the person who is going to use the pump should select from the friction tables the size of pipe to use on a job. It is safe to say that the velocity of the liquid at the discharge of the pump should be about 10 to 12 ft. per sec. This is good design; however, it may vary from 5 to 15.

## The Affinity Laws

There are certain basic theoretical affinity laws that govern the action of a centrifugal pump, but although these laws in themselves are immutable, they must be adapted in practice to actual pumping requirements. This the designer has done very satisfactorily as will be shown later. It is necessary, however, to a complete understanding of the subject, to become thoroughly familiar with these theoretical affinity laws.

When the diameter of the impeller remains the same:

1. Quantity will vary as the speed,
2. Head will vary as the square of the speed, and
3. Power will vary as the cube of the speed.

To illustrate these rules:

A pump operating at 1700 r.p.m. delivers 500 gal. per min. against a 60 ft. head and requires 15 hp. What quantity will it deliver at 1420 r.p.m.? The quantity will be in direct ratio of the speeds and is:

$$\frac{1420 \times 500}{1700} = 418 \text{ gal. per min.}$$

To determine the head developed at the higher speed, consider the square of the speeds:

$$\frac{1420^2 \times 60}{1700} = 42 \text{ ft.}$$

The power required has, of course, decreased because of the smaller quantity delivered and the reduced head duty. Using the power rule we find:

$$\frac{1420^3 \times 15}{1700^3} = 8.7 \text{ hp.}$$

Graphic illustration of this example is shown in Fig. 2.

Changes in speed such as these are usually dictated by a change in frequency of the electric current provided and the speeds used in the examples are representative of standard full load speeds of induction motors at 60 and 50 cycles, respectively.

Operating conditions in a refinery often call for changes in the operating characteristics of a centrifugal pump within a much narrower range and these changed characteristics can in many cases be attained by making a change in impeller diameter. The practicable limits of these changes in impeller diameter can be found by consulting the curves of the particular pump. These are usually supplied by the manufacturer.

The effects of the changes in impeller diameter are found by using the same rules previously used and simply considering the diameter rather than shaft speed. Assume a duty for a pump of the characteristics first stated, which duty requires the constant delivery of considerably less quantity of liquid. For the purpose of the example say that the original diameter is 8 in. Reduced to 6 in. by turning off 1 in. all around the reduced delivery will be:

$$\frac{500 \times 6}{8} = 375 \text{ gal. per min.}$$

The effect upon the available head duty is:

$$\frac{60 \times 6^2}{8^2} = 34 \text{ ft.}$$

Power is:

$$\frac{15 \times 6^3}{8^3} = 6.3 \text{ hp.}$$

## Calculation of Power

Thus far we have not considered the question of power required for pump-

### AUTHOR'S NOTE

**The subject discussed in this article has been one of the writer's hobbies for many years and its representation, in my opinion, has never been adequate. This, then, is my contribution to that end. In preparing the article every effort was made to:**

**(1) Avoid repetition of facts that are so generally understood as to be axiomatic.**

**(2) Establish in the mind of the reader the reason for each point discussed by acquainting him with features of design of the equipment and with the properties of the liquids pumped.**

***—The Author.***

# *Even in These Times...*

We find it possible to complete our Plant projects with efficiency and in reasonable lengths of time, due largely to our having complete facilities within one organization, namely:

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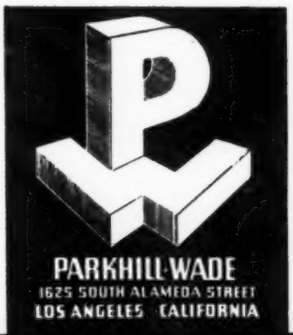
We are not straying from the beaten path we have laid down for ourselves — i.e., we are not taking on projects foreign to our experience and setup, but rather we are working along the lines of activity for which our organization, personnel, technical knowledge and training fit us best.

**Our ability to handle all phases of projects speeds completion and assures efficient, economical installations.**

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ing except in the manner and degree by which it is affected by changes in peripheral speeds of a centrifugal pump.

Before going into calculation of power there are two things that must be thoroughly understood, one of which applies only to a centrifugal pump. The head created by a centrifugal pump is not a pressure head, as in the case of a displacement pump, but is a velocity head. This velocity head depends entirely on the velocity of the liquid as it leaves the pump, which velocity is produced by the speed of the impeller. This velocity head must be sufficient to overcome the total resistance in the discharge line. Total resistance is the sum of the effects of:

1. Frictional resistance in the line,
2. Vertical height of the point of discharge above the pump,
3. Specific gravity of the liquid.

The point now to be emphasized is that none of these factors has anything to do with the static head that can be developed by the pump itself. They enter the problem only when the liquid is moving through the line and being discharged.

For example, assume two identical pumps discharging under the same conditions and both running at the same speed. Pump No. 1 will handle water and No. 2 will handle mercury. The peripheral speed is capable of developing a velocity head of 100 ft. The pumps are started and it will be observed that both the water column and the mercury column will stand at the same height in a standpipe representing a discharge line. As both pumps run at the same speed both liquids, regardless of their specific gravity, will stand at the same height in the standpipe. (See Fig. 3.)

The difference in the weights of the liquids will be reflected in the pressure gauges. For the purpose of illustrating the principle it will be assumed that the discharge line is large enough in diameter so that the pipe friction can be neglected. Both gauges will show the pressure of the column of liquid in the respective pipes. Gauge No. 1 will read 43 lb., which is the weight in lb. per sq. in. of a column of water 100 ft. high. As mercury is 13.6 times as heavy as water, gauge No. 2 will show 13.6 × 43 or 585 lb. per sq. in. and the power required to operate the No. 2 pump will be 13.6 times that for the No. 1 pump handling water.

The foregoing example can also be used to illustrate the effect of the viscosity factor, although to do so will require a somewhat more elastic imagination. If one of these pumps was supplied with a viscous oil, the liquid would eventually rise to the same point in the standpipe as either the water or the mercury, but a much longer time would elapse because some of the velocity head would be used in overcoming the frictional-resistance-due-to-viscosity. The latter part of the climb up the standpipe would be very slow because an increasing percentage of the available velocity head would be used in maintaining the vertical head already attained. When the oil reached the 100-ft. level, however, a flow could not be maintained because the entire velocity head of the pump would be consumed in holding the level, with none remaining to balance the head loss due to the flowing oil.

One more point is to be considered before proceeding with a calculation of power required for pumping. The pump has only a relatively small degree of control over the power required to pump a given quantity per unit of time of a liquid of stated specific gravity and viscosity. The effect of frictional resistance in the line usually is the greatest factor in the total resistance to flow. As this frictional resistance is controlled largely by the viscosity of the oil and the unit cross-sectional area of the line, it should be understood that reduction of viscosity and/or an increase in line size is more likely to be effective in reducing power than a more efficient pumping unit. This is true in the case of a displacement pump, but the advantages are compound with a centrifugal as will be fully brought out in a subsequent article.

## Calculation of Power

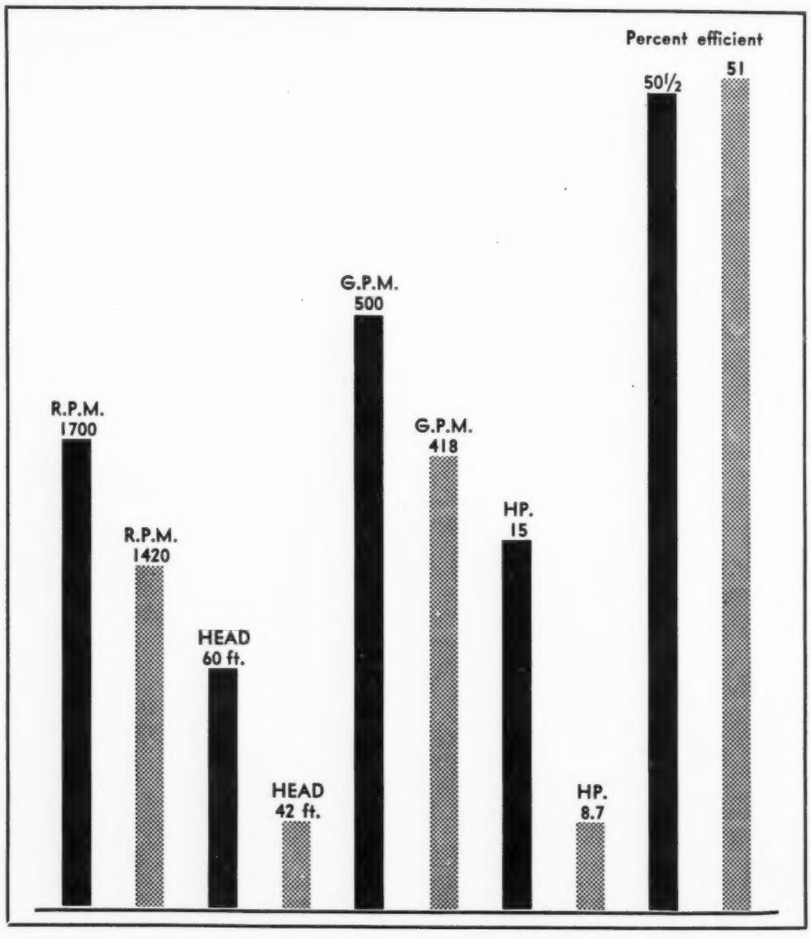
The power required for pumping depends primarily upon two conditions: (1) the weight of the liquid to be pumped per minute, and (2) the total resistance to its flow. The basic formula for horsepower will apply.

Hp. = 33,000 ft-lb. minutes. Therefore:

$$\text{Hp.} = \frac{\text{Wt. of liquid pumped in lb. per min.} \times \text{total resistance in ft. of water}}{33{,}000}$$

As the lb. per sq. in. exerted by a column of water 1 ft. in height, 0.434 lb., is the unit of head commonly used

*Fig. 2. Illustrating theoretical affinity laws when diameter of impeller remains the same and speed is reduced*



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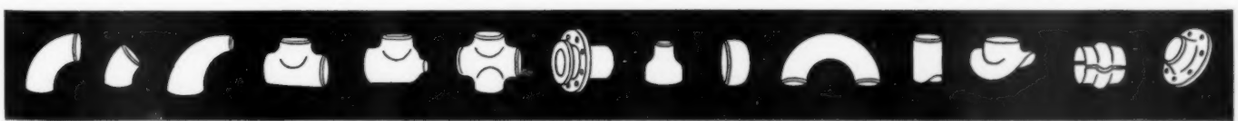

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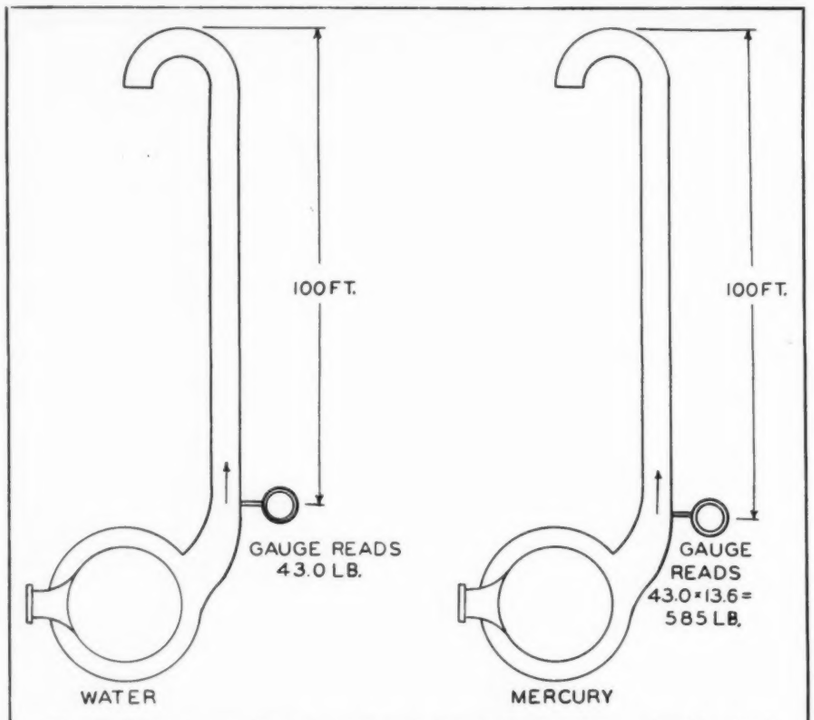


*Fig. 3. Pumps operating at same speed and discharging under identical conditions lift water and mercury to same height in standpipe*

the formula is simplified by correcting for the weight of a gal. of water, 8⅓ lb., and the formula becomes:

$$\text{Hp.} = \frac{\text{gal. per min.} \times \text{head in ft. of water}}{3960}$$

We now have a formula that accounts for everything except pump losses. The pump may be all the way from 50 percent to 90 percent efficient. This figure also is largely within the control of the pump user. If the pump is selected with good judgment, and given proper line conditions, a higher degree of efficiency may be expected. Accounting for this the formula becomes:

$$\text{Hp.} = \frac{\text{gal. per min.} \times \text{head in ft. of water}}{3960 \times \text{pump efficiency}}$$

When the calculation is made in forecasting the power demand when pumping liquids other than water the figure obtained will require correction for specific gravity by multiplying the figure by the actual (not A.P.I.) specific gravity of the liquid.

The reader is referred to a previous article[1] for a complete discussion of this point. The charts mentioned in a footnote to that article, *Pipe Friction Chart for Calculating Friction Loss Through Pipe Lines for Oil, Water, Gasoline or Distillates* and *Pipe Friction Chart for Viscous Flow*. The writer has found these charts to be of great value in such work. They are to be found in the *Data Section of Standards of Hydraulic Institute*. This pamphlet can be obtained from the Hydraulic Institute, 90 West Street, New York City, at a nominal price.

If the power calculation is to be made for a unit already in operation, divide the pressure gauge reading by 0.434 to obtain head in ft. of water. The overall efficiency of the unit, then, is the relationship of the actual input of power to that shown by the calculation that did not take efficiency into consideration.

It must be remembered that the power figure found by these calculations is the power demanded by the pump, and does not represent the power required to be supplied to an electric motor that might be the means of driving the pump. The usual induction motor can safely be given an efficiency of 95 percent and the electrical horsepower that it will demand for a given load is equivalent to the pump hp. divided by 0.95.

[1] "A Specific Problem in Refinery Piping Design" by R. G. Lovell, *The Petroleum Engineer*, March, 1941.

☆☆☆

P 027.2

# Emergency Specifications and Changes Developed By A.S.T.M.

SINCE the procedure was established in 1941 by the American Society for Testing Materials for preparing emergency provisions and complete emergency specifications or tests, a number of such actions has been developed by A.S.T.M. technical committees. All changes and the new specifications have one aim, namely, the expediting of procurement and conserving critical or strategic materials during the national emergency. The committees that have taken emergency action included the following:

A-1 on steel
A-5 on corrosion of iron and steel
A-10 on iron-chromium-nickel alloys
B-1 on copper wires for electrical conductors
B-2 on non-ferrous metals and alloys
B-5 on copper and copper alloys
B-6 on die-cast metals and alloys
D-1 on paint, varnish, lacquer
D-11 on rubber products
D-12 on soaps and other detergents

To make the emergency actions effective quickly, the A.S.T.M. procedure provides for approval in an appropriate subcommittee, endorsement by the chairman of the main standing committee and then approval by the Society's Committee E-10 on Standards, a reviewing committee consisting of six outstanding authorities, long-time A.S.T.M. members, who must decide whether the group has reached a substantial consensus.

Five complete emergency standards have recently been issued by the Society covering lead-coated and lead-alloy coated copper wire for electrical purposes, hot-dip lead coating on hardware, method for conducting salt spray tests on organic protective coatings, hardness conversion table for cartridge brass, and carbon-chromium ball and roller bearing steels. In addition, alternate provisions are provided in more than 42 standards, which can be used by the purchaser as a permissible alternate for the specific application or use.

☆☆☆

# Applying the Mechanical Integrator to Orifice Meter Measurement*

**☆ Chart integrator employing the square root cam idea calculates any static and differential range combination**

**PART 1**

*by J. L. Cottrell*

Manager, Integrator and Orifice Meter Division, Pittsburgh Equitable Meter Company

THE correct amount of gas measured for any time period is a very important factor to the industry, as a large amount of the production, main line measurements, and industrial sales of gas is measured with orifice meters. Extensive research has taken place during the last ten years by joint committees of the American Gas Association and The American Society of Mechanical Engineers with the coöperation of the U. S. Bureau of Standards, Washington, D. C., in proving the accuracy of orifice meter flow coefficients and making important, definite recommendations concerning the correct way to install this type of equipment so that the most accurate results may be obtained. This work is having an important effect on the improvement of measurement with orifice meters.

During the last 25 years, constant improvement has been made by the users and manufacturers of orifice meters to increase the efficiency of a complete orifice meter measuring unit, and all measurement men have become quite accuracy conscious during the last few years; and even though some existing contracts permit variation in measurements of 3 percent, all companies are striving to measure gas within a few tenths of 1 percent. Reducing orifice meter measurement to a few tenths of 1 percent error has required continuous thought in designing and applying equipment to approach the fine point of accuracy desired.

*A revision of a paper entitled "The Emco-McGaughy Integrator and Its Application to Orifice Meter Measurement," presented by J. L. Cottrell before the Southwestern Gas Measurement Short Course, and a similar paper presented before the Appalachian Gas Measurement Short Course, 1941.

**J. L. COTTRELL**

was born in Illinois, 1905—Reared and educated in Kansas—Joined the Union Gas Corporation in 1923—Resigned as assistant superintendent of gas measurement, 1929—Joined the J. B. McGaughy Integrator Company, inventor of the McGaughy Integrator, 1929—Was with that organization until purchased by Pittsburgh Equitable Meter Company in 1931—Employed in the Pittsburgh Equitable Meter Company's Engineering and Manufacturing Department in Pittsburgh from 1931 to 1934—In charge of integrator manufacture and sales from 1934 to present time.

## Chart Integration

This article is devoted to the subject of chart integration. The same mathematical problem of arriving at the total extension of orifice meter charts exists today that was present when the orifice meter was first used by the industry.

The reading of charts is sometimes referred to as an "accounting procedure," but in reality any operation of this type remains a measurement problem until the correct volume has been determined for each orifice meter chart. The importance of the gas measurement department is apparently being given more consideration by all companies during recent years, and the management of these companies realize that each step taken from the field to the office has a definite bearing on the accuracy of orifice meter measurement.

As the principles of orifice meter measurement are fairly well understood, only the final formula used in most measurement work will be given here, showing various corrections as recommended by the A.G.A. Report No. 2.

The final formula used in most measurements will be:

$$Q = C' \sqrt{H P_A}$$

Where:

- $Q$ = Rate of flow (cu. ft. per hr.)
- $C'$ = Hourly coefficient
- $H$ = Differential pressure for any given hr. (in. of water)
- $P_A$ = Absolute static pressure for any given hr. (lb. per sq. in.)

The total expansion on orifice meter charts can be computed by what is known as the observation method, which requires taking an average static and differential reading for each hourly or 15-minute period, and then getting the extension for that particular combination of static and differential readings from extension tables that are available in book form, totalizing the extension for any time interval, and then multiplying by what is commonly known as the orifice coefficient or basic

orifice meter factor, as outlined in the preceding formula. This method of calculating orifice meter charts is a very slow and tedious task and, when a large number of charts is to be computed each day, involves considerable expense.

The most objectionable feature to the observation method of reading charts is the human element involved in determining the approximate values of static and differential recorded. Most companies prefer to use charts that are graduated in pounds of pressure and inches of water, as this type chart is sometimes more desirable for field use. It must be remembered when reading these charts by observation that although you are looking at a scale that appears to be graduated in equal divisions, it is in reality a square root scale. Whether a pounds-of-pressure-and-inches-of-water chart is used or a square root chart, it is difficult to average accurately the recorded flow, for no one has a square root eye for satisfactorily averaging these values.

The square root chart has been used by some companies. By using this direct scale chart, it is necessary to multiply the chart reading of H and $P_A$ to attain the value of $\sqrt{H\ P_A}$. This method eliminates the necessity of referring to the extension tables for any combination of static and differential values.

In the inspection method of calculating charts and other existing methods, certain theoretical discrepancies are found due to taking the square root of average values over infinite time intervals, whereas the formula calls for instantaneous square root values.

There is also some error found due to the fact that the static pressure and differential pens on the orifice meter never track on exactly the same time arc on the chart; therefore, the correct time lag is not taken into account with any method of calculation except when an integrator is employed.

The inspection method is more or less of a compromise, except for the time lag mentioned, and would become more accurate as the finite time intervals used approached zero. Such procedure, however, would involve an infinite number of calculations, hence the use of the 15-minute or hourly method as a compromise.

The integrator eliminates the need for compromising on the time interval and presents an extension that is the summation or integration of an infinite number of instantaneous values of the square root of the product of absolute pressure and differential values. Furthermore, each instantaneous value of pressure is sychronized with its corresponding value of differential. Thus, the result rendered is theoretically perfect.

During the course of development and the wider use of orifice meters there have been very few successful types of mechanical methods developed to simplify the problem of reading orifice meter charts. Radial planimeters were developed, then square root planimeters, which retraced just one line on the orifice chart at a time. The results obtained were fairly accurate, provided the static and differential lines did not fluctuate too much.

In 1927, J. B. McGaughy, then employed by one of the large gas utility companies in the Middle West, foresaw the need of a faster and more accurate device for calculating orifice meter charts; and with this idea in mind, he concentrated his thoughts on an integrating device that would be theoretically perfect in its application, and also practical from the standpoint of its application to the industry.

His original idea was to develop an integrating type orifice meter; experiments showed, however, that in a number of applications it was impracticable to use gas or electricity for power to drive the required mechanism. An experimental model of an integrator was built, however, to be used in the office to calculate the total extension after the static and differential lines had been recorded on the orifice meter chart.

There are three basic ideas on which an integrator can be designed—the square root cam, the triangulation theory, and the cone. In reality, the cone idea is actually a cam. The triangulation theory is very good theoretically; experiments have shown, however, that the square root cam is the most desirable and practical to use and makes the integrator cover a much broader application as to the types and ranges of charts that may be calculated.

In April, 1928, a revised model, similar in some respects to the machines made today, was manufactured and sold to one of the large gas utilities companies in December, 1928.

In April, 1931, all the patents on the McGaughy type integrator were purchased by one of the leading meter manufacturers. The engineering and research staff of the company made a number of experimental tests and in 1930 designed an integrator employing the triangulation theory.

After considerable development and actual tests, it was decided that the McGaughy machine, which employed the square root cam idea, had certain advantages over the triangulation theory. Consequently, attention was devoted to improvement and further development of the square root cam type machine, resulting in the present machine, which can be utilized to calculate any static and differential range combination of the three well-known makes of orifices meters used by the industry.

## Theory and Construction

The integrator operates by translating into revolutions and multiplying the three given values of the chart, namely, time, square root of pressure, and square root of differential, and summing up the products in terms of revolutions. An infinite number of instantaneous values are multiplied and summed up for each chart.

The machine is comparatively simple and rugged in construction, and accurate precision machine standards have been closely adhered to throughout. Essentially the machine consists of three disks or plates, which may be termed the chart plate, the time plate, and the pressure plate.

The time plate and chart plate are geared together in constant ratio and are driven by a variable-speed motor. The pressure plate is situated above the time plate, and geared to the pressure plate is a small steel roller termed the pressure roller. This roller bears on the face of the time plate and is shiftable across it from center to outside edge. Thus, by shifting the position of the pressure roller, it is possible to change the speed ratio between the time plate and pressure plate. A second roller termed the differential roller is shiftable across the face of the pressure plate and directly connected to this roller is a simple revolution counter. It may be said, therefore, that the mechanism includes a driving plate and two superimposed frictional speed changes in series, all driving a revolution counter.

Spring and balance weight tension are employed to hold the differential and static carriage rollers in positive contact with the rubber surface of the time plate and pressure plate, as the torque required to drive the static and differential carriage steel rollers is very slight, and the power required to turn the index counter is practically negligible, possible slippage in the frictional drive is entirely eliminated.

The static and differential carriage rollers that contact the two rubber covered plates are mounted in two sealed-type ball bearings, which give exceptional wearing qualities under severe use and further eliminates the possibility of friction loss.

Two pen arms equipped with fountain pens rest on the chart plate. These pen arms contact with the face of the chart when it is resting on the chart plate. The ends of these arms are connected through a system of levers and square root cams, which are attached

—Photo by Meisel

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to the static pressure and differential carriage rollers, respectively.

This linkage is so arranged that the pen arms serve to move the carriages so that at any instant the point of contact of these rollers with the respective plate surfaces will correspond in revolutions respectively to: the square root of the absolute static pressure being registered at that instant by the pressure pen, and the square root of the differential being registered at that instant by the differential pen. Two control arm handles on the front of the machine serve as a means of moving the pressure and differential arm across the face of the chart while tracing the two recorded curves.

Analyzing the action of the machine, the time plate turns a definite number of revolutions while the chart plate turns through a certain known time division on the chart, for example, one hour. At any instant during this time the pressure roller is engaged in multiplying the square root of the absolute pressure being indicated at that instant by the pressure pen by this instant of time. For example, if the pressure pen is resting on 85.6 lb. static pressure (assuming 14.4 atmospheric) or 100 lb. absolute, the pen arm linkage will force the pressure roller to that distance from center of time plate that will cause the pressure plate to revolve exactly ten revolutions, or the square root of 100, whereas the chart plate turns through one hour's time.

The revolutions turned by the pressure plate, therefore, during any instant of time equals $T\sqrt{P}$ where time equals that fractional part of one hour represented by the instantaneous reading and P is the absolute pressure at that instant.

The differential functions in the same manner, the differential pen being linked through a square root cam with the differential roller, so that for any indicated differential, the linkage forces the roller to a distance from the center of the pressure plate that is equivalent to $\sqrt{D/r}$, where r is the radius of the differential roller. For example, if the differential pen rests on 25 in., then the position of the differential roller is such that it will turn exactly five times (the square root of 25) for each complete revolution of the pressure plate.

The revolutions of the pressure plate, therefore, are multiplied by the square root of instantaneous differential, and, as pressure plate revolutions equal $T\sqrt{P}$, then the net resultant in revolutions registered by the counter equals $T\sqrt{P} \quad \sqrt{D}$ for any one instant or the summation of this expression for any definite time interval.

The result rendered by the integrator, therefore, is the absolute integration or theoretically true value of the extension on the chart.

In view of the theory on which the integrator operates, if it is desired to check quite closely with the results obtained by this method, it would necessitate breaking down the time intervals read by the observation method to as small a time interval as possible, which would then make it possible to check more closely with the integrator.

The differential pen on the integrator follows the arc line, and the static pen follows the same time lag or distance in advance of the differential pen. This can be adjusted to any time lag desired. When instructing the men caring for orifice meters, most companies specify that the time lag shall be set at 15 minutes or some other time spacing at the zero position on the chart.

This will eliminate any possible dispute when setting the time lag on the orifice meter; for if we simply say set the orifice meter with a 15-minute time lag, it may be 15 minutes at some certain working range on the chart, which obviously will be more than 15 minutes as it approaches the zero line, and will be less than 15 minutes as the pen travels to the outer edge of the chart.

It is more desirable to adjust all orifice meters to an even lag than it is to make adjustments of the time lag on the static pen with relationship to the differential pen on the integrator. All integrators are adjusted with a 15-minute time lag at the zero position on the chart on all pen centers unless other spacing is desired by the user.

## Time Stop Mechanism

The integrator is equipped with an automatic time stop mechanism, and the underneath side of the chart plate is milled out with 96 slots—one for each quarter of an hour on a 24-hour chart. An indicator that swivels from the center shaft on the underneath side of the chart plate to the edge of this plate is designed so that it points to the differential pen that follows the arc line on all charts.

This time indicator can be set to calculate an even 24-hour or 7-day period or any portion thereof. For example, if we were to calculate a 24-hour chart that covered an even 24-hour period, the chart would be placed on the integrator with the chart set exactly as it was set on the orifice meter—that is, with the differential pen at the starting position of the differential line on the chart. The time indicator would then point directly to the differential pen. The time indicator would then be released, the static and differential lines would be traced, and the machine would stop automatically at the end of an even 24-hour period.

If, however, a 24-hour chart had run, say, 26½ hours, the chart would be placed on the integrator at the starting position corresponding to the way it was set on the orifice meter, and the time indicator would be shifted to the left of the starting position 2½ hours. Then 2½ hours of the chart would be read, and the machine would stop automatically at its original starting position. Then the time indicator would be released and the remaining 24 hours would be traced and the machine would again stop at the end of that period.

Should the chart recording be for less than a 24-hour period, it would be placed on the integrator in the same manner as described, the time indicator would be shifted to the right corresponding to the time interval recorded on the chart, and the machine would then stop automatically at the end of this period, thus eliminating revolving the chart plate through hours of time where no flow is recorded.

When the time indicator is released, it automatically trips an auxiliary counter that is built into the base casting of the machine indicating one count. This enables the operator to keep an accurate check on the number of charts traced during any hour or day. This counter may be cleared by turning a thumb screw and will reset at the zero position.

Underneath the machine there is a small gear case, which is equipped with a motor. The motor is a Universal type, designed to operate on 110 volts, either a-c. or d-c. current, 25 to 75 cycles. This motor drives the time plate shaft to which the time plate is attached on the topside of the machine. On the time plate shaft in the gear case is a small spiral gear, which drives a line-shaft connecting to a gear placed directly under the chart plate.

A rheostat rests on the floor and connects to the integrator and wall socket connections. The operator may vary the speed of the chart plate to any speed desired, which makes it possible to trace the most irregular charts with ease and precision. The speed of the chart plate can be varied by this means, but as the time plate and chart plate are directly connected by gear arrangement, the ratio of revolutions of the time plate and chart plate always remains the same. When the time indicator trips off at the finish of a chart, the chart plate stops at that exact instant.

EDITOR'S NOTE: The next installment of this article will appear in an early issue.

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P 934.314.

# Prevention of Fires, Explosions, and Accidents From Inflammable Fluids*

✰ Information on fires, explosions, and especially flame propagation in industries handling inflammable fluids such as petroleum products

PART 1

by G. M. Kintz

Supervising Engineer, District G, Health and Safety Branch, U. S. Bureau of Mines

## Introduction

SCIENCE changes the methods used in warfare, and war changes the mode of living and the industries of a nation. It is asserted that during past wars two workers in industry could keep a soldier supplied, but owing to mechanization the present war requires 18 workers per soldier. This change also means that to a great extent victory depends on a continuous flow of necessary supplies, which in turn depends on ever-increasing speed of mass production by industry. Mass production is based upon coördination of many plants, machines, and workers. Should a fire, explosion, or accident delay any part, it may delay the whole and mean the loss of a vital battle. *This must not occur.*

It is generally recognized that the safe way is the most efficient and economical; therefore, accident and fire prevention, on or off the job, cannot be stressed too much.

The pressures and temperatures used in processing inflammable petroleum products present many opportunities for fires and explosions to occur accidentally or by sabotage. Everything possible must be done to prevent sabotage, but when a fire or explosion occurs, extreme care must be taken to determine the real cause and not, because of favorable public opinion, to attribute it to sabotage unless that is actually the cause.

Any process or equipment that may cause a fire, explosion, or accident must be remedied. For example, a serious explosion occurred in a chemical plant of one of the nations at war. This explosion could have been attributed to sabotage; however, thorough investigation revealed that during the process the product passed through a stage that was not known to exist; even if it had been known, the compound that was formed would not have been considered to be explosive. As a result of careful investigation, the process and product were improved, and no further explosions have occurred.

These things are mentioned to stress the fact that now, as never before, every person working in industry should know the fundamental causes of fires and explosions so that they can be eliminated or fought efficiently.

One of the major activities of the U. S. Bureau of Mines is to promote safety in the mining, petroleum, and allied mineral industries. Such activities require the Bureau to help determine the explosion hazards of combustible gases, fumes, and solids and to investigate means of controlling and preventing fires and explosions. Much of this work can be done in the laboratory, but Bureau of Mines engineers or other recognized authorities should also be permitted to investigate thoroughly fires and explosions in the mineral industries. Coöperation in such investigations by these industries will help to prevent similar occurrences in other plants necessary to national defense.

The Bureau of Mines course on "Safety in Handling Petroleum Products, Especially Gases," which has been conducted for various companies in Texas and Louisiana, explains most of the fundamentals and contains many demonstrations that reproduce in miniature several such fires and explosions and show some of the causes and preventive measures. Only a few of these experiments can be discussed here, as the complete course requires 15 to 20 hours.

**G. M. KINTZ**

obtained a degree of engineer of mines with a major in oil geology from the Colorado School of Mines—After leaving school he spent a year working in the metal mines of Arizona and then went with an oil company as assistant geologist in Oklahoma during the time the Osage Nation was being developed—From there he went into oil shale work and assisted in operating the only successful oil shale plant in the United States, which was at Elko, Nevada—From his experience derived there he went into government work investigating oil shale claims throughout western United States—He entered the Safety Division of the Bureau of Mines in 1926—In 1937, at the request of the Mid-Continent oil companies, a district office of the Health and Safety Branch of the Bureau was opened in Dallas, Texas, and Kintz was assigned the job of district engineer—Since that time he has been developing the lectures and demonstrations that are being presented throughout the United States.

## Fundamental Causes of Fire

The fundamentals of fire, which are simple and should be understood by everyone, are described fully in Bureau of Mines Information Circular 7150, a copy of which may be obtained free upon written request to any office of the U. S. Bureau of Mines.

Circular 7150[1] describes demonstrations proving that, to have a fire, some form of combustible matter must be present to burn as a fuel; as regards most petroleum products, this combustible matter must be in the form of a vapor. This is demonstrated by passing a block of wood and a card through a flame, and by placing a burning match in kerosine, without firing the substance; however, when the wood

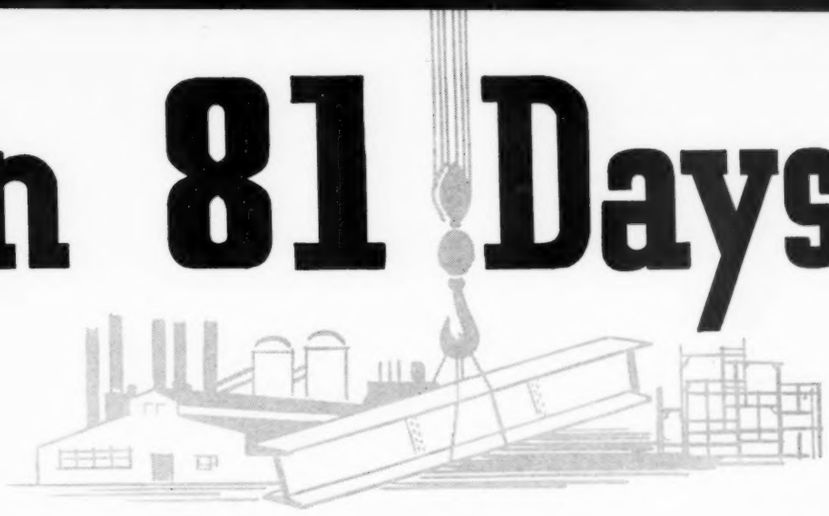
*Published by permission of the Director, U. S. Bureau of Mines. Presented before the Petroleum Industries Association of South Texas, Alice, Texas, Feb. 11, 1942, and before the meeting of the Mid-West Safety Conference, Chicago, Ill., May 5 to 7, 1942.

[1]Kintz, G. M., Some Information on the Causes and Prevention of Fires and Explosions in the Petroleum Industry: Bureau of Mines Inf. Circ. 7150, 1941, 28 pp.

*(Continued on Page 80)*

# Built for Steel Prog

# ...am in 81 Days!

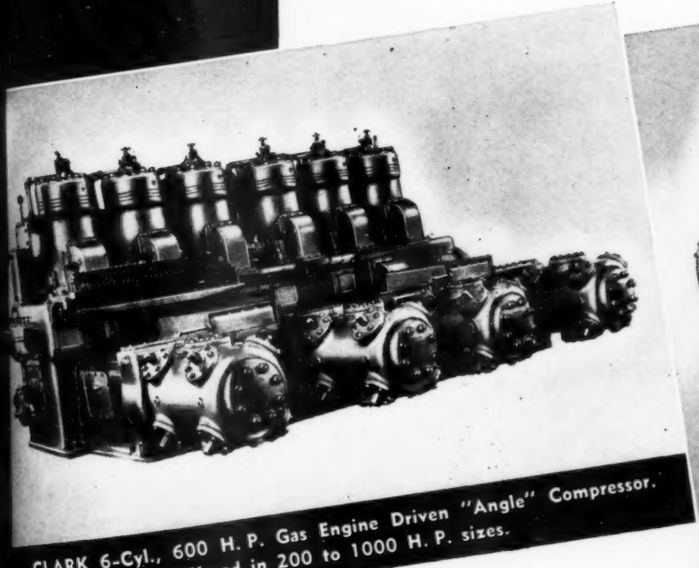


TO MEET the demands of the war steel production program, the Carnegie Illinois Steel Corporation recently required additional volume of natural gas for their mills in the Pittsburgh area. It was essential that the increased supply become available not later than December 15th, 1941.

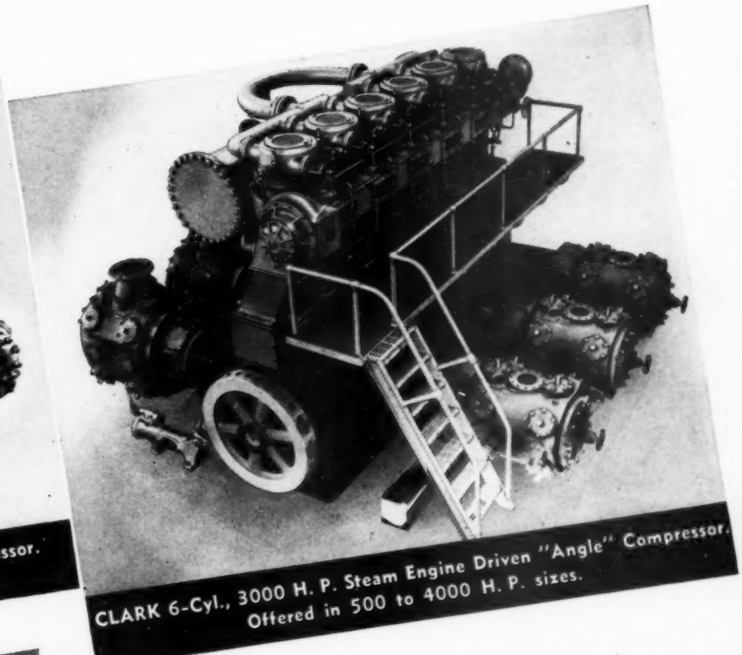
On September 16th, authorization was issued to construct an 1800 H.P. compressor plant on the United Fuel Gas Company's 16-inch line to the Pittsburgh area, — which would increase the line's capacity about 15 Million CF per 24 hours. The same day Clark Bros. received an order for the installation of three 600 H. P. "Angle" Compressors needed.

The station was completed and ready for operation December 5th, 81 days after the authorization was issued and 10 days ahead of the requirement. Special credit for this achievement was due D. S. Keenan, President of Carnegie Natural Gas Company, H. M. Baker, chief engineer of the United Fuel Gas Company, and the Clark engineering department.

CLARK compressors are in tremendous demand for such major war industries as high-octane gasoline production, explosives and chemical manufacture, etc. Clark men are doing their part to meet every requirement. If you need compressor equipment for war production, you can depend on it no stone will be left unturned to make delivery ahead of schedule.



CLARK 6-Cyl., 600 H. P. Gas Engine Driven "Angle" Compressor. Offered in 200 to 1000 H. P. sizes.



CLARK 6-Cyl., 3000 H. P. Steam Engine Driven "Angle" Compressor. Offered in 500 to 4000 H. P. sizes.

CLARK BROS. CO., INC., Olean, N.Y. Export offices: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Tex.; Chicago, Ill. (122 S. Michigan Ave.); Boston, Mass. (131 Clarendon St.); Huntington Park, Calif. (5715 Bicket St.); Foreign Offices: 72 Tunmill St., E. C. 1, London; Avda Roque Saenz Pena 832, Buenos Aires.

# CLARK

*(Continued from Page 77)*

and kerosine are heated, they give off vapors that burst into flame in contact with a source of heat of sufficient duration and intensity, proving that to have a fire with petroleum products of inflammable liquids it is necessary to have at least two things—vapor and heat. Placing a spark plug in a jar of gasoline shows that heat and vapor are not the only requisites, as no fire occurs until the spark plug is raised above the top of the jar, where the gasoline vapors are mixed with air.

A triangle was developed to illustrate graphically that, where inflammable liquids are concerned, a fire can occur only when heat, vapor, and air are present simultaneously. In other words, so-called inflammable liquids do not burn; it is their gas or vapor that burns. In reality, therefore, it is the prevention and extinguishing of gas fires that should be considered.

Many inflammable substances do not have to be heated above normal temperatures before inflammable vapors are emitted. Gasoline is probably the most common among a long list of such substances. Liquids of this character should not be carried in glass containers. Most filling-station attendants will not fill a glass container with gasoline if one is taken to them. Such liquids should be stored or carried in types of containers approved by some accredited agency. When gasoline is stored in an approved container a burning match may be applied to the open top and a fire will occur; when the opening is closed the flame is extinguished. Many persons would not think of applying a match to a tank of gasoline, but those same persons will use it to clean floors or clothing—a practice that is far more dangerous.

## Causes of Explosions

These experiments explain what causes a fire. An explosion may be explained somewhat similarly. When a flask of water stoppered with a cork containing a hole is heated above the boiling point no explosion will take place because the excess vapors escape through the hole. This hole represents the safety valves on boilers, tank wagons, air receivers, and similar vessels. Gasoline tank wagons and other containers of inflammable liquids are involved in fires, but if they meet the Interstate Commerce Commission's specifications, or those of any nationally recognized authority, there is little danger of an explosion.

Tanks containing inflammable liquids do explode, but so do boilers, air receivers, and many other vessels; that the content is an inflammable liquid, water, or air is not always a factor. Explosions frequently occur because of structural defects or weaknesses, or excessive pressure with improper vents or safety valves to relieve the pressure, and not necessarily because of the nature of the liquid or gas the tanks contain.

When a flask of water is stoppered with a solid cork and heat is applied until the water is above the boiling point, excessive pressure in the flask forces the cork out with a loud noise, indicating that an explosion is the sudden release of stored energy.

It is interesting to note that as the cork is blown out a considerable quantity of water is carried with it. Had this liquid been gasoline or other inflammable liquid, a very serious fire might have resulted.

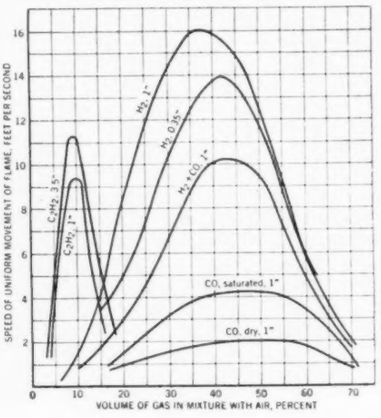



*Fig. 1. Flame speeds of various simple gases*

The hazard of gas being generated in inflammable liquid was described by C. R. Miller[2] as follows:

> An interesting illustration of this nature occurred a number of years ago in one of the Southern States. A tank car of casinghead gasoline was placed on a siding and exposed to the heat of the sun for a considerable time. Some workmen then proceeded to unload the car, and their first step was to remove the dome cover without gradually reducing internal pressure through the safety valve. When the cover was loosened, the contents of the car actually boiled over, and huge quantities of vapor escaped into the air.
>
> There was a slight wind blowing from the car toward a group of negro shacks some one hundred yards away. The vapors were rolled along by the wind, picking up and becoming mixed with air as they moved along. When this cloud of vapors struck the shacks, it was ignited by fire in a stove and a terrific explosion took place—not at the tank car but actually at the row of shacks. Eventually the fire flashed back to the tank car and ignited it, but there was no explosion there, simply a violent combustion off the top of the dome, which was finally extinguished. The explosion actually took place fully 100 yards away from the tank car, and most of the damage resulted at this point.

## Extinguishing a Fire

To have a fire involving inflammable liquids, it is necessary to have the three elements, vapor, heat, and air (oxygen); it should be possible to extinguish a fire by removing any one of them. This can be illustrated by making some tests with a lantern chimney having a small glass inlet tube for inflammable gas, a large glass tube extending through a tight cork in the bottom of the chimney, and a flat piece of metal with a hole in it over the top to reduce the size of the opening. The tests also reproduce some facts about the fires that have occurred.

The belief is general that to have a flame or fire with a jet of inflammable gas, it must be surrounded by air or oxygen. The following experiment gives the impression that it is possible also to burn air in gas. Inflammable gas is fed into the chimney through the small tube at the bottom until all the air is displaced. When the hole in the cover of the lamp chimney is closed, the gas may be ignited at the end of the large tube that projects from the bottom. When the hole is opened and an upward draft is created, the flame of the burning mixture will proceed up the tube, and soon a flame will be seen at the end of the air tube burning in an atmosphere of pure inflammable gas; that is, air is combining with gas to burn in gas. As an excess of gas is flowing into the chimney, the gas flowing from the hole in the metal cover at the top of the chimney also may be ignited; therefore, popularly speaking, this flame represents gas burning in air.

It is not true that gas burns in air or air burns in gas, because a flame is a phenomenon produced at the surface where two gases meet and undergo combination, with the evolution of heat and, more or less, light.[3] From a chemical standpoint, therefore, it makes essentially no difference whether the gas on the outside of the flame contains oxygen and inflammable gas is on the inside, or whether the order is reversed; in other words, it is the mixture of inflammable gas and oxygen that burns, not the pure inflammable gas or the pure air (oxygen).

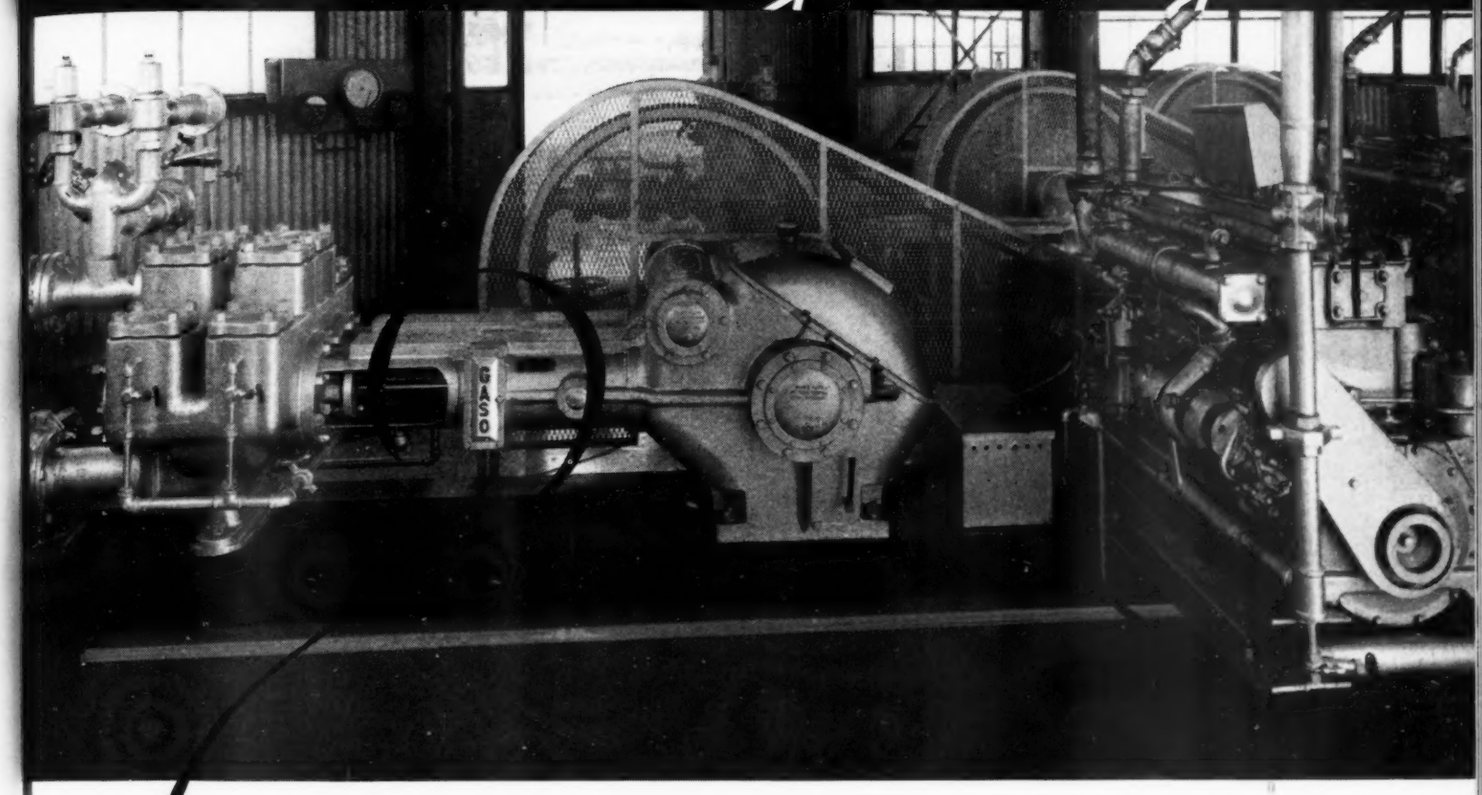
This experiment also illustrates how the flame from a burning torch may be sucked into a tank as the oil is pumped out, unless some device is used, such as a flame arrester or a liquid seal.

The principle of the flame arrester can be illustrated by placing fine-mesh wire screen (approximately 28 openings to the linear inch) across the opening in the cover at the top of the chimney and igniting the gas above the screen. The screen may be held in the hand, and as it is raised slowly the flame stays above the gauze and the gas beneath it does not fire. If the wire gauze

[2]Miller, C. R., consulting engineer, White Star, Ohio Division, Socony-Vacuum Oil Company, Inc., Detroit, Michigan.

[3]Smith, Alexander, General Chemistry for Colleges: Century Company, New York, 1908, p. 337.

# WHEN THE INSTALLATION BEARS THE STAMP OF *Real Engineering*—

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is raised higher, a point is reached at which the flame is extinguished. The wire gauze does not burn the hand nor become hot immediately. The flame does not travel through the gauze, because the small wires conduct the heat away rapidly enough to prevent it from being transmitted to the gas below the gauze. Therefore, it can be seen that a fire can be extinguished by taking away either of the two sides of the triangle, namely, the air or the heat side.

That a fire can be extinguished by removing the third side of the triangle can be proved by using a two-holed glass flask, which might be said to represent the storage tank at a filling station. To one of the holes is connected a curved glass tube to represent a vent pipe.

The location of the vent pipe is important in any storage tank for gasoline or other easily vaporized, inflammable liquid. Many supply stations have blown up because the vent pipe was not high enough to permit the vapors to be diluted with air before they drifted into adjacent buildings; some vents have been placed inside the building, certainly a very dangerous type of installation. The vents should extend well above the top of the filling station and should be placed so the vapors will be dissipated without danger of ignition or of being blown into inhabited buildings in concentrated form.

To continue the experiment, a little gasoline is poured into the flask that represents the underground storage tank, as there is almost always some liquid gasoline in the underground storage tank of an operating filling station, even though it may appear to be empty. Gasoline vaporizes at relatively low temperatures, hence the space above the liquid in a gasoline container may be filled with those vapors. To illustrate how a severe accident may occur, assume that a tank-wagon driver is delivering a load of gasoline into the underground tank. The bulb-shaped funnel, filled with gasoline, represents the truck; the valve at the bottom of the funnel represent the valves at the back of the truck, and the tube leading from the funnel to the flask or bottle represents the hose from the truck to the underground tank. Assume, also, that as the gasoline flows into the underground tank some careless motorist, entering or leaving the filling station, strikes a match, and the flame ignites the gasoline vapors issuing from the vent pipe. If the driver would step to the tank truck and close the valve controlling the flow of gasoline, the fire would be extinguished because the fuel supply would be stopped.

In this experiment it will be noted that the fire does not follow down the glass vent tube into the flask, because there is not enough oxygen in the tube or flask to support combustion. In other words, a long vent pipe is not needed to prevent fire from entering a gasoline storage tank; length is necessary only to carry the fumes to a safe distance. This fact may be demonstrated by removing the glass tube and cork and again allowing gasoline to flow into the container and by igniting the vapors issuing from the large opening. When the supply of fuel is shut off, the flame is extinguished.

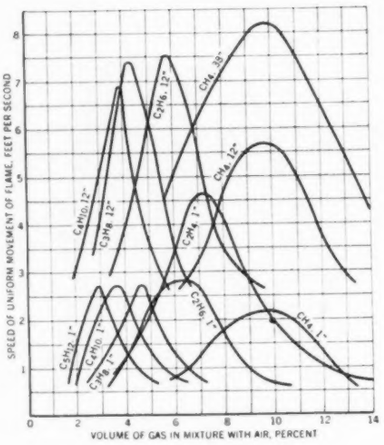


*Fig. 2. Flame speeds of various hydrocarbon gases*

Before leaving the subject of vents, it is well to stress again the need for making certain that the vents are high enough for the vapors to be diluted properly in the atmosphere, and are placed so that the vapors will not drift through a window or other opening of a filling station or some adjacent building. In moderate climates it may not be necessary to place a screen over the mouth of the vent to prevent the flame from traveling back into the tank; on the other hand, it is desirable that the mouth of the vent should be open so that the vapors will always have a means of escape.

On New Year's eve, December 31, 1941, a flood in Baton Rouge, Louisiana filled an underground gasoline-station storage tank, causing the gasoline to flow out a low vent pipe onto the water. This gasoline ignited, and burning gasoline on the running water did a great deal of damage. Had high or proper vent and loading pipes been used, this would not have occurred.

So far, only vessels that contain a volatile fluid, filled or partly filled tanks, and cans at temperatures that will vaporize the liquid have been considered. Containers termed "empty" (that is, containers that have been filled with a volatile fluid that gives off an inflammable vapor and have been virtually emptied) will now be discussed. An ordinary gun has to be loaded before it can explode, but "emptied" cans of gasoline, alcohol, lacquers, paints, and other similar liquids are very likely to explode when a flame or an electric arc comes in contact with them. It is the so-called empty container, with its small residue, that is extremely dangerous, not the loaded container, which contains a liquid that vaporizes at the temperature of the container and usually is equipped with proper safety valves.

When one drop of gasoline is placed in a small lucite cylinder, which is corked, the gasoline allowed to vaporize, and heat applied through a toy-airplane spark plug, a loud explosion occurs; this represents a so-called empty container.

Safety-minded persons are sometimes criticized for recommending that there be no smoking around laboratories where chemists may be running tests by heating inflammable liquids to temperatures that cause them to vaporize, and a Bunsen burner is on the table with a flame on it. Whether it is safe may be tested with the equipment just mentioned. One drop of gasoline is placed in a lucite cylinder, which is corked. Heat is applied by creating a spark at the top plug, but no explosion occurs. Heat is then applied by a spark at the bottom plug, and an explosion occurs, showing that the vapors, being heavier than air, were hanging along the bottom.

The following story illustrates this condition. A chemist, who was a lover of dogs, had a bird dog of which he was especially fond and allowed it to follow him into the laboratory. After a time the dog began to lose weight, then stopped eating, and finally died. No direct evidence as to the cause of the dog's death was determined until a few weeks later, when someone walked into the laboratory, lighted a cigarette, and dropped the burning match on the floor, whereupon a flash of flame swept the floor. The dog had been breathing an atmosphere different from that inhaled by the man, owing to accumulation along the floor of vapors heavier than air.

One drop of gasoline in the cylinder causes an explosion, but when three drops are placed in it, and the cylinder is corked, the gasoline allowed to vaporize, and heat applied, no explosion occurs; yet the cylinder contains the three elements of the triangle. If the cylinder is uncorked and some of the vapors are allowed to escape and the heat is again applied an explosion occurs.

The "fire" triangle might appear to be in error; this is not necessarily true, although the elements constituting the triangle must be present within well-

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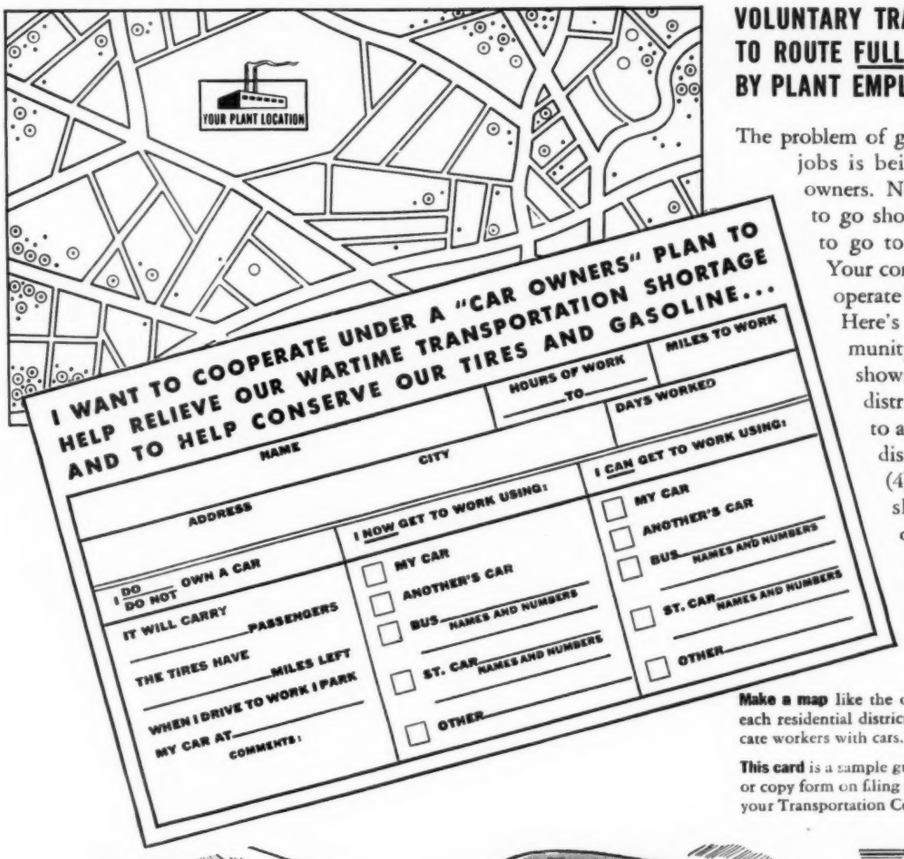
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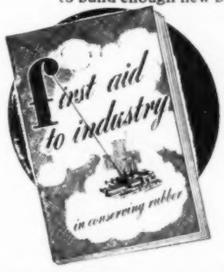


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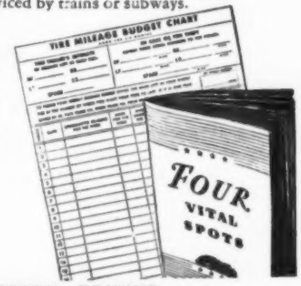


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defined limits. The amounts of inflammable gas and air must bear a definite relationship to each other, and the heat present must be above a certain temperature. If there is too much or too little air or gas an explosion will not occur. It is impossible to have too much heat, but there can be too little heat, as will be indicated later.

This experiment shows that a fire or explosion will not occur unless there is a definite relationship between the amounts of oxygen and inflammable gas present. If there is too little or too much of either an explosion will not occur. This relationship is called "limits of inflammability." Jones[4] states:

> Confusion has arisen regarding the meaning of the terms "explosive limits," "inflammable limits," and "limits of inflammability." These different expressions, in the final analysis, mean the same thing. Some investigators regard explosive limits as those limiting mixtures within which flame will propagate through the entire volume of the mixture and develop considerable pressure, while inflammation limits or limits of inflammability are regarded as those limiting mixtures within which flame will propagate through the mixture indefinitely, irrespective of whether or not pressure is developed.

Jones' statement can be proved by extinguishing the flame of the Bunsen burner, filling the cylinder with the gas coming from the burner, corking the cylinder, and applying a spark. When this is done an explosion occurs, yet in the open the same mixture burned in a flame.

## Flame Propagation

The speed with which a gas burns depends on many factors, such as the kind of gas, the mixture of the gas with oxygen, the size of the container or pipe, and the distance the gas travels. The meaning of "flame speed" can be demonstrated with a tube (1-in. glass tube 4 ft. long) and a Bunsen burner. So long as the flow of gas through the tube is faster than the speed with which the inflammable mixture in the tube will burn, the flame remains at the end of the tube; but if the flow of gas is reduced, the flame travels against the flow into the mixing chamber of the burner. This fact is important in the prevention of many fires and explosions in industry as well as in the home. If the opening in the orifice of a gas appliance becomes clogged or dirty, the flame may travel into the mixing chamber rather than burn on top of the burner. In many instances flash-backs in gas- and liquid-fired boilers are due to the speed of flame. Welders working on gas lines have the saying, "When she starts to take air, get out, because there will be an explosion." Often the explosion has already begun, because, as the line was "burned into," the gas on the inside was ignited and began to burn slowly away from the point of ignition. When sufficient pressure has built up ahead of the flame to prevent it from traveling farther, it may "kick back" and cause a forceful explosion.

A glass tube 2 in. in diameter, 15 ft. in length, with 1-in. circular openings every 30 in., is filled with a mixture of approximately 4 percent butane in normal air. When the mixture is ignited at one end by means of a spark, the flame travels through the tube at tremendous speed, but only certain of the tissue-paper diaphragms covering the 1-in. openings are ruptured. The tube is again filled with approximately the same mixture, and when fired some but not all of the same paper diaphragms are ruptured. This demonstrates that pressure is built up ahead of the flame and that the points where it reaches sufficient pressure to rupture the disks vary. This action demonstrates what often takes place when an explosion occurs in a city or refinery sewer, in a long building such as the New London school, and what occurred when 27 miles of pipe line exploded in the Texas Panhandle (as was reported in the technical press of December, 1939).

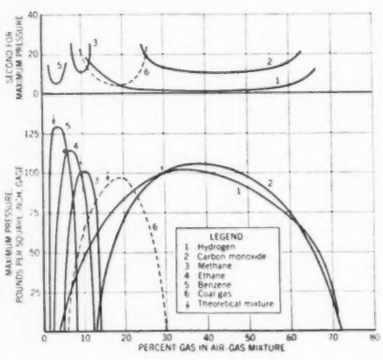


*Fig. 3. Explosion time and pressure for mixtures of gas and air*

This variation for a fixed percentage is due to many factors—the moisture in the tube, the source and point of ignition, turbulence of the mixture, and many others, all of which are beyond the scope of this article.

The tube is now filled with a mixture of approximately 7 to 8 percent butane in normal air. When it is ignited the flame moves through the tube so slowly that one can walk along with it and none of the paper diaphragms will be broken. This demonstrates that an explosion may occur without developing enough pressure to cause damage (note moisture condensed on walls of tube).

The speed and pressures that are developed under certain experimental conditions are shown in Figs. 1, 2, and 3.

Fig. 3 was prepared by Jesse S. Gean and Louis Schnidman for an article entitled "Explosion Pressures for Combustible Gas-Air Mixtures," an abstract of which was published in the monthly bulletin of the American Gas Association for January, 1939. Fig. 1 and 2 were compiled from U. S. Bureau of Mines Technical Paper 427 and International Critical Tables and published in the Gas Engineers Handbook (McGraw-Hill Book Company, 1934).

The speed and pressure developed by a gas-air mixture depend upon many things; two of the most important are the gas and its ratio to the oxygen present.

Speed and pressure begin to develop at the lower inflammable limit of a gas-air mixture, increasing until the mixture reaches approximately the mid-point, and then decreasing as the mixture approaches the upper inflammable limit (Figs. 1, 2, and 3).

Flame of most petroleum gases will propagate upward over wider inflammable limits than in any other direction. This vertical 2-in. glass tube, 4 ft. long and closed at the top, is filled with an inflammable 4- to 5-percent butane-air mixture. When ignition takes place at the bottom end the flame travels slowly a short distance, then accelerates, and as it approaches the closed end it is traveling at its maximum speed. As the flame moves through the tubes a humming noise is audible, which, when it reaches the closed end, becomes a sharp explosion. The humming noise is due to the vibration of the flame.

The vertical tube is filled with a rich mixture (approximately 7 percent butane-air), and when ignited at the bottom the flame assumes a teardrop shape with a comet-like tail as it proceeds slowly up the tube (note moisture on walls of the tube).

Flame propagation in the open can be exemplified by an inclined open trough. Cotton waste saturated with gasoline is placed at the top of the trough and a lighted candle at the bottom. When the proper mixture of inflammable vapors reaches the candle, the flame travels up the trough to the source of fuel. No noise is heard, because the flame is not confined and has no pressure to work against. The principle of the flame arrester again can be demonstrated by inserting a screen in the trough. The flame then stops at the screen.

EDITOR'S NOTE: The concluding installment of this article will appear in an early issue of *The Petroleum Engineer.*

☆ ☆ ☆

[4]Jones, G. W., Explosion and Fire Hazards of Combustible Anesthetics: Bureau of Mines Report of Investigations 3443, 1939, 17 pp.

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# So, You Want to be a Petroleum Engineer?

PETROLEUM ENGINEER EXCLUSIVE Feature

## PART 6—*Petroleum Engineering Schools of the United States (continued)*

*by Lester C. Uren*

Professor of Petroleum Engineering, University of California

**UNIVERSITY of Oklahoma.** The University of Oklahoma is situated at Norman, Oklahoma, population about 11,400, only 18 miles south of Oklahoma City, the State Capital and an important oil-producing center. Tulsa, another important oil industry center, is about 120 miles northeast. Founded in 1890, the University did not establish its Petroleum Engineering Department until 1924. The College of Engineering embraces 11 schools, one of which is the Petroleum Engineering School, another the Natural Gas Engineering School. The curriculum in chemical engineering affords opportunity for training in oil refining. Separate four-year curricula are prescribed in each of these fields.

Professor W. H. Carson is dean of the College of Engineering and director of the Schools of Petroleum Engineering and Natural Gas Engineering. Professor R. L. Huntington is director of the School of Chemical Engineering. W. F. Cloud, author of a well-known book on petroleum production technology, is professor of petroleum engineering. W. C. Bednar is associate professor of petroleum engineering; G. M. Stearns is assistant professor of petroleum engineering, and E. M. Sims is instructor in petroleum engineering. Several members of the Mechanical Engineering Department devote much of their time to instruction in the mechanical phases of petroleum and natural gas engineering and members of the Chemical Engineering Department are also largely concerned with petroleum technology instruction. A comprehensive program of instruction in the geological sciences is offered by the Department of Geology and Geography, several courses being designed particularly for petroleum engineering students. Members of the petroleum engineering staff have been active in the conduct of petroleum industry research and have made important contributions to the literature of this field.

**A photograph and biographical sketch of the writer can be found on Page 7 of the January issue of *The Petroleum Engineer*, in connection with Part 1 of this series.**

During the academic year 1940-41, the University had 7054 students enrolled in the regular sessions; of these, 1634 were engineering students, and a large part of the engineering group were petroleum engineering students. This is one of the largest groups of petroleum engineering students in the United States—a circumstance that may be regarded as an expression of the importance attached by the people of the State of Oklahoma to their petroleum industry—the result also, of a competent faculty in this field of instruction, and of excellent educational facilities.

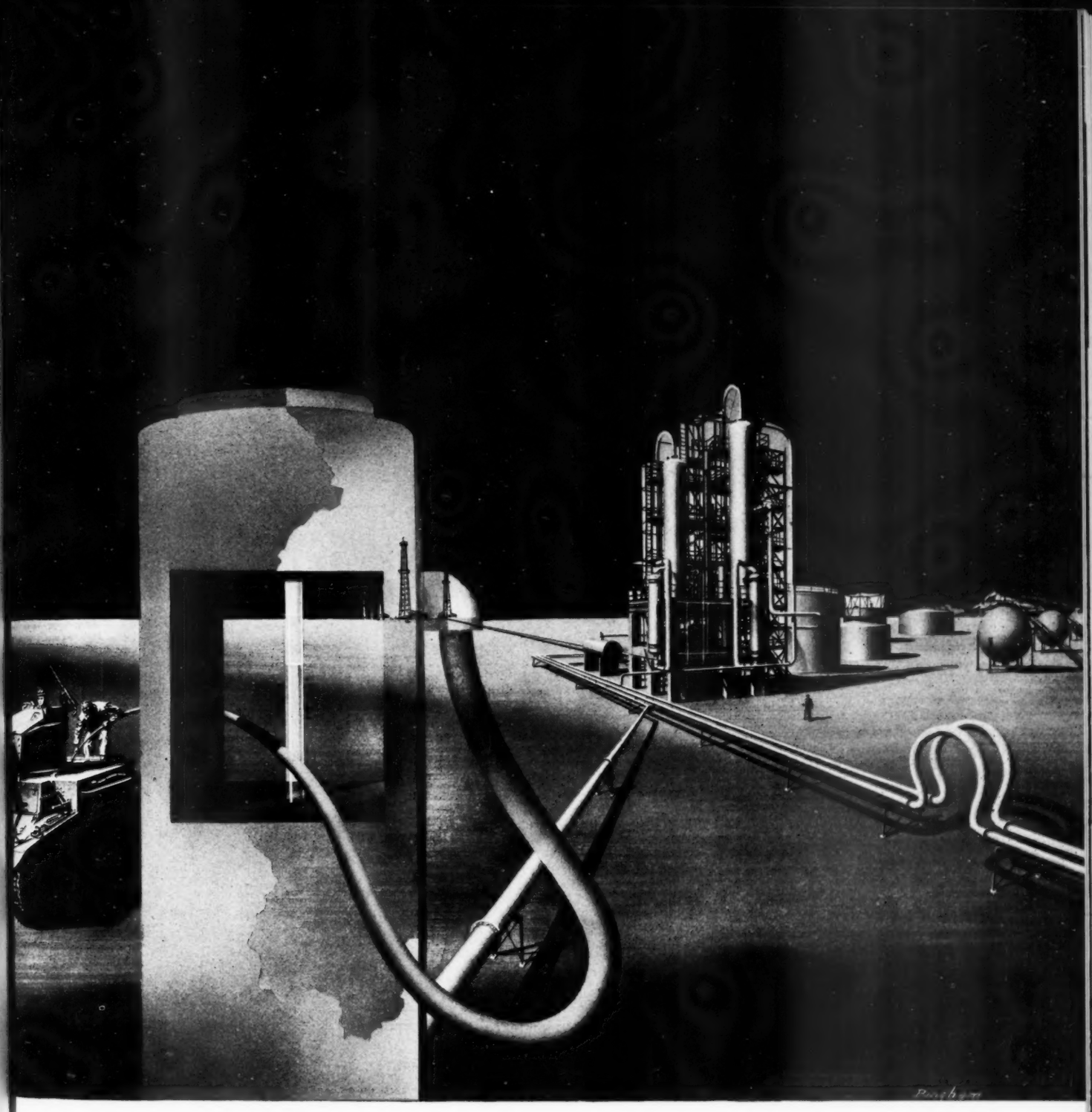
The Petroleum Engineering Department is housed in the Engineering Building and nearby laboratory buildings. An outdoor laboratory is equipped with field and plant-scale oil-producing and refinery equipment. A separate building houses the Department of Geology and the headquarters offices, laboratories, and scientific collections of the Oklahoma Geologic Survey. A file of 70,000 Oklahoma well logs and many thousands of formation samples from the oil-producing fields of this region are available here for reference and research.

Petroleum production and refining are important industries in Oklahoma, a large segment of the population deriving livelihood from them. Among the oil-producing states of the United States, Oklahoma ranks third. Many producing fields and refineries are within a few hours automobile drive of the University and important oil-producing districts of neighboring states are not far distant. University of Oklahoma students are therefore favorably situated for practical contacts with Mid-Continent oil industry operations.

*This modern structure houses the Petroleum Engineering Department at the Missouri School of Mines, Rolla*

**The University of Tulsa.** The University of Tulsa is situated in the City of Tulsa, Oklahoma, a fine modern community of approximately 160,000 people whose citizens call it the "oil capital of the world." The University had its origin in its present form in 1920 and derives its revenue from various endowment funds and student fees. The Petroleum Engineering Department was organized in 1928 and enjoys the income from a special endowment fund provided by Waite Phillips, a prominent oil company executive, who has also provided an attractive building that houses the several engineering departments and the Department of Chemistry.

The University of Tulsa dignifies the profession of petroleum engineering in its organization by providing a College of Petroleum Engineering, with a petroleum engineering curriculum affording a "major" in either petroleum production or petroleum refining. Stu-



# Victory will be measured in gallons

When you hear, with bated breath, how close the enemy has come to a victory with some raid of fifty or a hundred planes, you may wonder what merciful fate kept them from using a thousand. It was likely lack of fuel, not *fate*, that stayed them.

To reach more oil, the Axis has been flailing about Europe and Asia like a monster, sacrificing lives by the hundreds of thousands.

The American petroleum industry, with half the world's reserves, and a tremendous production of the finest gasolines and oils, is our greatest guarantee of ultimate victory.

In dozens of places between oil pool and battle line, piston rings are essential equipment. When the bit bites into the earth on a new location. When pumps lift oil from the sand, and drive it through pipelines. When compressors repressure oil sands, or take over a refining process. Each application has its own problems.

Koppers engineers learned something about solving the industry's piston ring problems from books, more through laboratory work, but most by living for 23 busy peace-time years with the industry's troubles wherever they occurred.

This close contact gave Koppers engineers a reservoir of experience that is helping petroleum engineers produce *more* oil products NOW—just as their experience also is helping engineers in other fields.

Here in Baltimore, three patriotic shifts are sweating night and day to blend that experience into today's rings.

Koppers Company, American Hammered Piston Ring Division, Baltimore, Maryland.

**KOPPERS**

**THE INDUSTRY THAT SERVES ALL INDUSTRY**

BUY UNITED STATES WAR BONDS AND STAMPS

*Hearst Memorial Mining Building, home of Petroleum Engineering Department, University of California*

dents in the College may also specialize in geology, geological engineering, chemistry, and general engineering. R. L. Langenheim is dean of the College of Petroleum Engineering. Professor W. L. Nelson conducts a program of courses in petroleum refining and the courses in oil-field exploitation are in charge of G. Umpleby. Professor S. Born supervises the petroleum research.

The University of Tulsa has a comparatively small student body, but, reflecting the major interest of the community in which it is situated, in 1940 had 250 students enrolled in the College of Petroleum Engineering. An interesting plan has been devised whereby petroleum engineering students spend about half of their senior year working in oil-industry occupations. The senior class is divided into two sections that alternate between industrial and academic work, the period of alternation being approximately eight weeks. Local oil companies coöperate by providing work in various capacities for the University's petroleum engineering students.

## Southern Institutions

In the southern block of states, bordering along the Gulf of Mexico, are five institutions offering curricula in petroleum engineering. These are: the University of Alabama, Louisiana State University, University of Texas, Texas Agricultural and Mechanical College, and Texas Technological College.

**University of Alabama.** The University of Alabama, situated at Tuscaloosa, a city of 27,500 inhabitants, dates from 1819. Instruction in petroleum engineering, however, began quite recently and is as yet under-developed. In 1941, a petroleum engineering curriculum was first announced as a division of the College of Engineering. Professor J. R. Cudworth, professor of mining, is in charge. The University of Alabama has an undergraduate student enrollment of 12,500, one of the larger student groups among American universities. Petroleum technology, however, is not emphasized and enrollment in this phase of engineering is small. Alabama has no petroleum industry of consequence, but nearby states offer opportunity for industrial employment and experience, particularly Louisiana.

**Louisiana State University.** Situated at Baton Rouge, an attractive city of about 35,000 people and the seat of the State government, Louisiana State University serves a student population of about 8300. Of these, about 700 are enrolled in the College of Engineering. Petroleum Engineering students on this campus numbered 186 during the academic year 1940-41, one of the larger petroleum engineering groups in the United States. Louisiana State University dates from 1860, but has been on its present site only since 1925. Beginning about 1922, a large group of modern buildings has been erected on the new campus, largely through the personal interest of the late Huey P. Long, former Governor and U. S. Senator.

Petroleum engineering instruction was initiated in this University in 1924 as a development within the School of Geology, but is now administered jointly by the School of Geology and the College of Engineering. Conduct of the program of petroleum engineering courses is entrusted to Associate Professor B. C. Craft and Assistant Professor S. Cromer. Excellent facilities are available for petroleum engineering instruction and are housed in a wing of the Geology Building, which is also shared by the technical staff of the Louisiana Conservation Commission. This commission is charged with administration of Louisiana's conservation laws in the state's oil-producing industry. The petroleum engineering students profit greatly by close association with this and other divisions of the School of Geology.

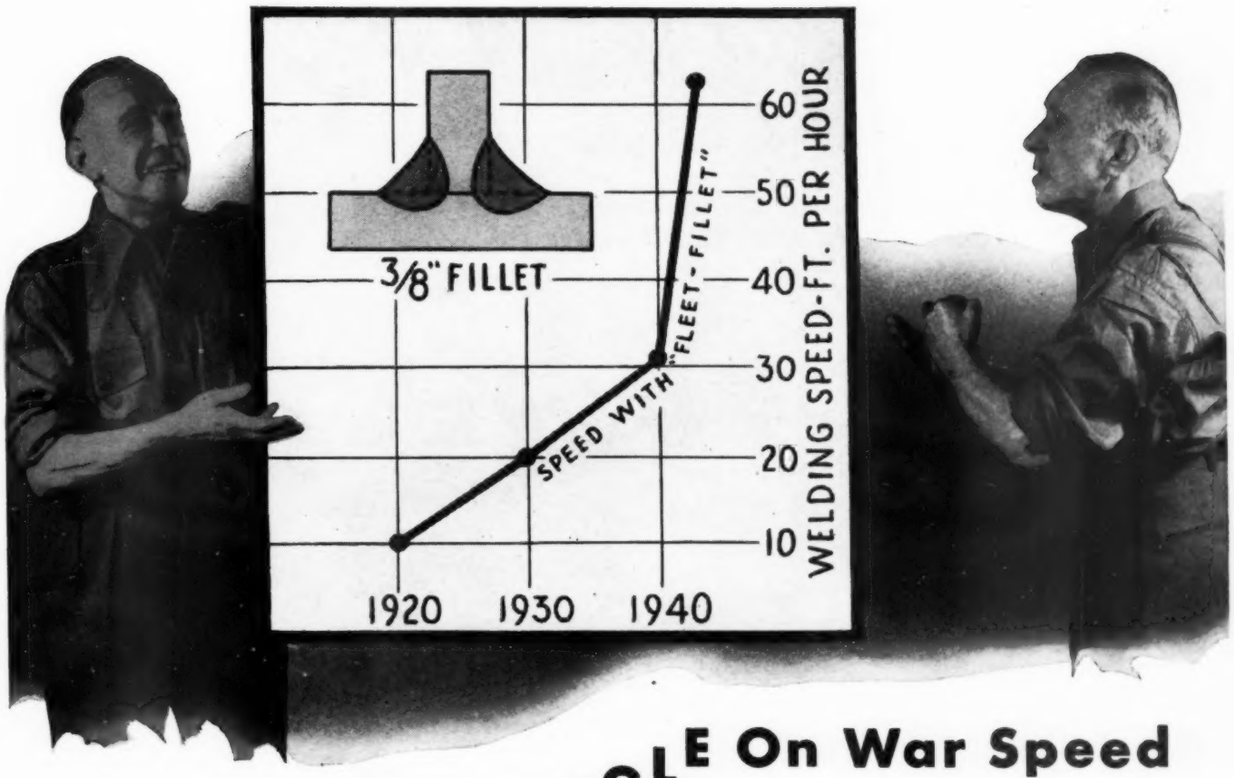
Louisiana ranks fifth among the oil- and gas- producing states of the United States and the oil fields of the Gulf Coast area of southern Louisiana and nearby Texas are presently the most active in the country. Students seeking their education in this area have many opportunities for field contacts. Petroleum engineering students are fortunate in that a producing oil field is situated on the campus of the University, and serves as a field laboratory.

**University of Texas.** Austin, the State capital, a fine modern city of about 88,000 population, is the site of the University of Texas. Established in 1881, it was not until 1918 that the University of Texas began to assume its present position as the leading educational institution of the southwestern United States. One of the reasons for its rapid ascendency during the last two decades, has been the very large sum of money that has been made available through oil royalties received from the leasing of University owned land. This has produced a capital fund of about $30,000,000, the interest on which, amounting to upwards of $800,000 annually, is available for buildings and permanent equipment.

The College of Engineering was created in 1894, but the Petroleum Engineering Department was not established until 1928. The curriculum in petroleum engineering, one of six offered by the College of Engineering, leads to the degree of bachelor of science in petroleum engineering. Another, that in chemical engineering, offers an option in petroleum engineering, directed more specifically toward training in oil refining. Professor H. H. Power is chairman of the Department of Petroleum Engineering. Other members of the department include Professors G. H. Fancher and F. B. Plummer and Instructors J. I. Laudermilk and A. E. Sweeney.

The University has in recent years had a student enrollment of about 11,000; of these, about 1800 are engineering students. Reflecting the importance of the petroleum industry in this state, the petroleum engineering group is the largest of the several engineering groups. In 1939, 544 petroleum engineering students were enrolled: one of the three largest petro-

*then I said to myself—*




# Here's a NEW ANGLE On War Speed

*Look how war industries can step up welding output with the new "Fleet-Fillet" Technique!*

**ALTER EGO:** Looks like arc speeds of 30 feet per hour have been increased to 65 feet per hour for a ⅜" fillet overnight. That's more than 100 percent. How could it be possible?

*According to Lincoln it's simply a matter of selecting the right electrode, using the new "Fleet-Fillet" Technique and going like blazes.*

**ALTER EGO:** But isn't that speed tough on the "Man Behind the Mask"?

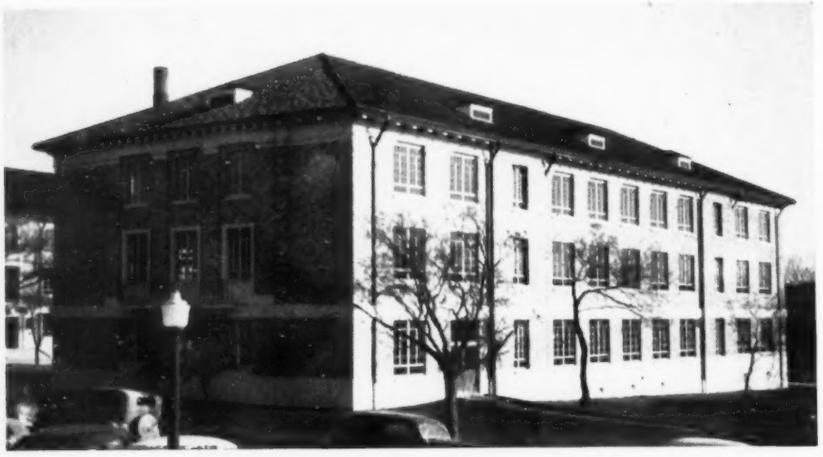
*Not at all. In fact, many welders who have tried this new technique say it actually is easier — causes less fatigue than the old way!*

**ALTER EGO:** Then every American—from the welder to the president—should go for it! Let's see the details in Lincoln's new bulletin "The Fleet-Fillet Technique For Speeding War Production and Cutting Costs." And let's put it to work for Uncle Sam without delay.

***"Fleet-Fillet" Bulletin 432 free on request.***

**THE LINCOLN ELECTRIC COMPANY**
**CLEVELAND, OHIO**

ALTER EGO: Literally, "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.



*Petroleum Engineering Building, recently completed at the University of Texas*

leum engineering groups in American Universities and colleges.

The University is favorably known for its graduate school, which ranks first among all the educational institutions of the South. The Bureau of Engineering Research, a phase of the work of the College of Engineering, offers opportunity for graduate students to engage in constructive research that may be applied toward a higher degree. The Bureau of Economic Geology provides a similar opportunity and, through its excellent series of publications, has greatly aided in the development of the natural resources of the state. The University's library, aggregating upwards of 600,000 volumes, is the largest in the South and contains outstanding collections in the fields of Latin-American culture, Texas history, and English literature. The University's summer session is one of the best attended in the United States and its Extension Division is one of the largest institutions of its kind.

The University of Texas is noted for its attractive campus and many fine modern buildings. Among the most recently completed structures is the Petroleum Engineering Building, undoubtedly the finest academic building in the United States devoted exclusively to petroleum engineering instruction and research. An outdoor laboratory contains some field-scale equipment available for instruction and demonstration.

Austin is but a few hours automobile drive from several important oil-producing districts and refining centers. Houston, the "oil capital of the Southwest" and headquarters for many oil companies operating in this area, is about 160 miles distant. Austin being the state capital, many oil industry interests are represented here, including the State Railroad Commission with its officials and many employees engaged in administration of the state's conservation laws.

With its competent faculty, excellent instructional facilities, and favorable setting, petroleum engineering at the University of Texas is setting standards that most other institutions in this field will find difficulty in matching.

**Texas A. and M. College.** The Agricultural and Mechanical College of Texas is situated at College Station, Brazos County, five miles from the city of Bryan and about 100 miles north of Houston. The population of Bryan is about 11,800. This institution is unique among petroleum engineering schools in that a large percentage of the male students live in college dormitories under semi-military regulations Large-scale dormitory and dining facilities, with financial assistance to many advanced Reserve Officer Training Corps students from the Federal Government, make for low-cost education.

The College dates from 1876, but it was not until 1929 that the Department of Petroleum Engineering was organized. The School of Engineering offers 12 curricula, among which are a four-year curriculum in petroleum engineering leading to the degree of bachelor of science, a five-year curriculum in petroleum and mechanical engineering leading to bachelor of science degrees in both petroleum engineering and mechanical engineering, and a five-year curriculum in petroleum engineering. The latter also provides a geological "option." Professor Harold Vance is chairman of the Department of Petroleum Engineering. Other members of the department are Professor A. B. Stevens (on leave of absence), Associate Professor J. P. Hays, and Instructor P. Martin. In addition to the regular staff, provision is made to present visiting authorities occasionally on special aspects of petroleum engineering in short courses of instruction.

In the academic year 1940-41, 6842 students were enrolled in the regular sessions. Of these, 582 were enrolled in the petroleum engineering curricula: one of the three largest student groups in the United States specializing in petroleum engineering.

An attractive building houses the departments of petroleum engineering and geology. Excellent facilities are here available for instruction in the more practical aspects of oil-field exploitation. An outdoor field laboratory provides opportunity for actual drilling and well operation experience. The College is fortunate in that it annually receives about one-third of the royalties derived from state-owned oil lands. Interest on the accumulated income from this source is available for buildings and permanent equipment. The Engineering Experiment Station undertakes research and investigation of engineering and industrial problems and disseminates information relating thereto. Administered as a department of the School of Engineering, the Experiment Station has its own permanent staff, but also offers opportunity for faculty members and advanced students to engage in research in which they may be interested.

Favorably situated in America's most prolific oil-producing state, within a few hours drive of several important oil-producing districts, students of the College have an excellent opportunity to study field operations.

**Texas Technological College.** Texas Technological College is situated at Lubbock, a city of 32,000 population in northwest Texas, about 300 miles north of Austin, the state capital. A comparatively young college, this institution was established in 1923 and opened its doors for students in 1925. Yet today it has 4100 students enrolled in its "long" session. Eight hundred and forty of these are engineering students, but the petroleum engineering enrollment is as yet small, only seven degrees being granted in this field during the academic year 1939-40. Petroleum engineering here has been a development within the Department of Geology and Engineering, and emphasis is on the geologic aspects of petroleum technology. In the petroleum engineering curriculum, the student may select either of three options: petroleum geology, geophysics, or petroleum production. Professor L. T. Patton heads the department. Instructor C. R. Horn conducts the petroleum production courses.

Like the other Texas institutions, this College enjoys close proximity to

# IT'S TIME TO TIGHTEN OUR BELTS ANOTHER NOTCH

Since the end of World War I, thousands of tons of nickel, chromium and other alloying elements have been employed to improve the qualities of steel. With ample supplies of these materials available, little thought was given to conservation. We wanted performance results, we got them.

But today, the picture has changed. We're in another war—a mechanized war—that demands the finest steels ever produced. Nickel, chromium and other substances have become critical alloying elements—because they're needed for *Production for Victory*—and because there just isn't enough immediately available to go 'round.

It's time to start pulling in our belts!

From the time when we began building for defense—now for victory—Republic has urged its customers to conserve critical alloys, and to cooperate with Governmental requests and restrictions designed for the protection of all.

To aid directly in conservation, Republic has continued its relentless research—its experimenting with new analyses which would save critical alloys, yet provide the qualities needed in steel today.

In most cases, it has been proved that critical elements alloyed in reduced quantities with steel would provide desired qualities when chemistries are properly balanced.

At the same time, Republic has warned customers of probable shortages, and has recommended *changes that eventually must be made.* Assistance has been given in the redesign of sections in preparation for keeping production moving with steels of lower alloy content—without sacrifice of needed qualities in the finished product. Suggestions have been offered on machining, forging and heat treating practices where changes were indicated.

America's greatest danger today is lost time in production. Never before in our history has time been so important. One airplane, gun or ship today may be worth a dozen tomorrow.

Republic is fully aware that its job today and tomorrow is to produce the best steel possible—with the materials available—for each specific need—and, to the utmost of its facilities, in the quantities required.

But Republic feels that this is only part of its duty. Hence, Republic's eagerness to be of greatest assistance to its customers—to help in the selection, application and fabrication of available steels to reach our mutual objective, *More Production for Victory.*

REPUBLIC STEEL
PRODUCTION FOR VICTORY

**REPUBLIC STEEL CORPORATION**

**Alloy Steel Division Sales Offices: Massillon, Ohio • General Offices: Cleveland, Ohio**

Berger Manufacturing Division • Culvert Division • Niles Steel Products Division
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★ ★ ★

ALLOY and CARBON STEELS • STAINLESS STEEL • PLATES • TIN PLATE • NUTS • BOLTS • RIVETS • NAILS • PIG IRON
BARS and SHAPES • STRIP • SHEETS • PIPE and TUBING • FARM FENCE • WIRE • FABRICATED STEEL PRODUCTS

*Petroleum Engineering and Geology Building, Texas A. and M. College*

fields of West Texas and southeastern New Mexico being but a few hours distant by automobile.

## Rocky Mountain Institutions

Two schools in the Rocky Mountain area offer specialized training in petroleum engineering, these being the New Mexico School of Mines and the Colorado School of Mines.

**New Mexico School of Mines.** The New Mexico School of Mines, founded in 1889, is situated at Socorro, a town of about 3700 population, 75 miles south of Albuquerque. Though but a small school of about 150 students and a faculty of 15, an ambitious program is offered covering all phases of the mineral industry of importance in the State of New Mexico. Petroleum engineering instruction began here in 1935. B. I. Routh, associate professor of petroleum engineering, conducts the petroleum engineering courses. Also situated at the School of Mines is the headquarters of the State Bureau of Mines and Mineral Resources.

New Mexico in recent years has developed an important oil-producing industry, particularly in the southeastern part of the state. Immediately adjoining, to the east and south, are the important oil-producing areas of West Texas. Many students and alumni of the School of Mines find employment in this industry.

**Colorado School of Mines.** The Colorado School of Mines is situated at Golden, an attractive town having a population of 3200, in a scenic section of Colorado about 12 miles west of Denver. The School of Mines was established in 1874 and has been favorably known for many years for its excellent training in the field of the mineral industries. The Petroleum Engineering Department was organized in 1921. Professor C. F. Barb and Assistant Professor J. O. Ball offer a complete petroleum technology program, including some graduate courses, and the Geology Department, headed by Professor F. M. Van Tuyl, a well known authority in this field, gives specialized courses in petroleum geology. The Colorado School of Mines is one of a very few institutions in the United States supporting a Department of Geophysics. This department, headed by Professor C. A. Heiland, a prominent authority in the field of geophysics, offers a variety of courses of interest to students specializing in petroleum exploration. A separate department, headed by Professor C. B. Carpenter, offers a program of instruction in fuel and gas engineering.

About 790 students were enrolled in the School of Mines during the academic year 1940-41. Of the senior class, 157 in this year, 35 or about 22 percent were petroleum engineering students. The school offers nine curricula, one of these providing a four-year program in petroleum production, another in petroleum refining. Others afford specialization in geology, geophysics, and fuels technology.

Berthoud Hall, which houses the Departments of Geology and Geophysics, is unquestionably the finest academic building in the United States devoted exclusively to the geological sciences, and instructional facilities in this field are excellent.

Colorado has about 20 oil and gas fields, most of them unimportant, and several small refineries. Regional isolation and limited local markets have delayed development of the petroleum industry in this state. Many oil and gas fields are also found in the adjoining states of Wyoming and New Mexico. Petroleum engineering students of the School of Mines, however, are not limited to experience in the Rocky Mountain region as faculty-conducted field trips for juniors and seniors are arranged each year into the more active Mid-Continent, Gulf Coast, and California districts.

## Pacific Coast Institutions

Three Pacific Coast institutions offer curricula in petroleum engineering, all in California. These are: the University of California, Stanford University, and the University of Southern California.

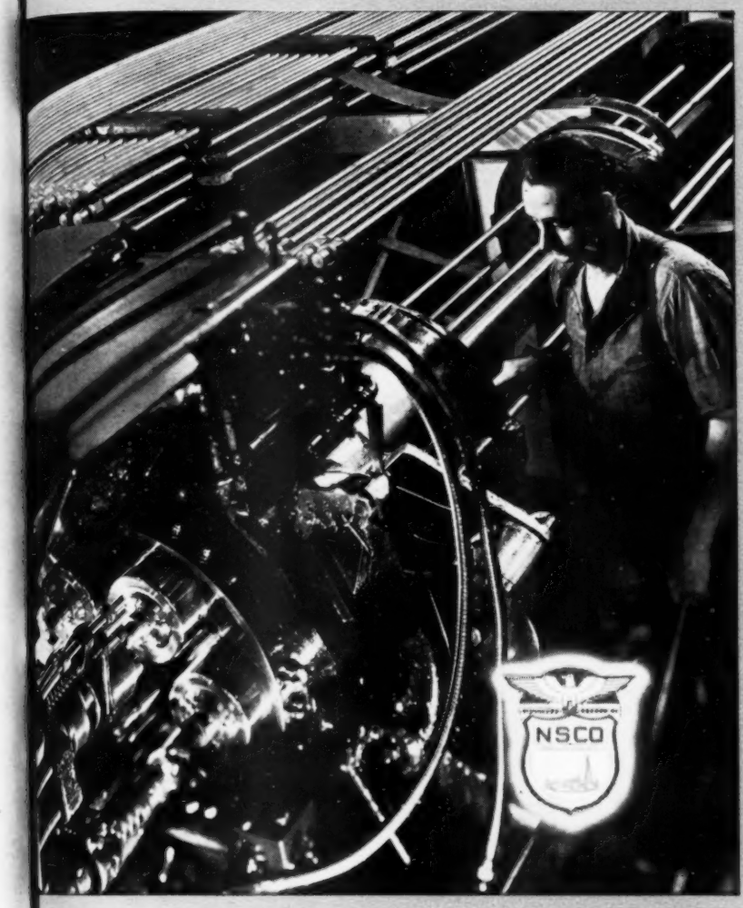
**University of California.** The University of California supports academic instruction on seven campuses, the most important of which are the Berkeley campus, with about 15,100 students and the Los Angeles campus (U.C.L.A.), with about 9,200 students. These figures for the 1941-42 academic year are about 8 percent below those attained during the previous year due to war-time demands on student personnel. This university is thus one of the largest institutions of higher learning in the United States. The University was founded in 1868, but instruction in petroleum engineering was not offered until 1913. The petroleum engineering curriculum, organized in 1915, was the first to be offered by any educational institution in the United States.

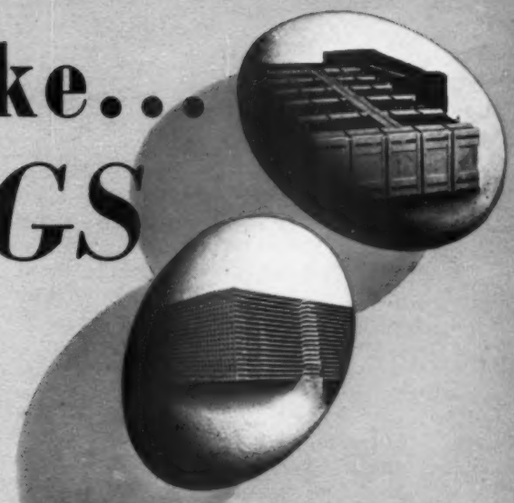
Instruction in petroleum engineering is offered only on the Berkeley campus, though the program of the first two years of the petroleum engineering curriculum can also be obtained on the Los Angeles campus. The petroleum engineering curriculum is one of four offered by the College of Mining, and petroleum technology courses are a phase of the work of the Department of Mining and Metallurgy. A complete program of courses dealing with different phases of petroleum engineering is conducted by Professors A. J. Carlson and L. C. Uren, the latter being the author of this series of articles.

Student enrollment in the petroleum engineering curriculum has, in recent years, ranged from 75 to 150. In addition, there are two other groups majoring in geology and mechanical engineering who are preparing for oil-industry employment.

The more general phases of engineering and the geological sciences are well developed in this university and afford an excellent background upon which to superimpose specialized instruction in petroleum engineering. Although the undergraduate curriculum provides a four-year sequence of courses, students are urged to spend an additional year in graduate work. Petroleum engineer-

# We Handle Them Like... *EGGS*



**Throughout the cycle of manufacturing processes, in transportation and in the storage of store stocks, every effort and precaution is exercised to guarantee to the users of National Sucker Rods a product from which they can derive the maximum of service.**

**It would, of course, be impractical to *"Handle Them Like Eggs"* in oil country service, but operators will get longer life from their National Sucker Rods by adopting the following Recommendations on the Care and Use of Sucker Rods which the A.P.I. has compiled.**

## *RECOMMENDATIONS ON CARE AND USE OF SUCKER RODS*

### STORAGE OF RODS

1. Store rods on a clean, smooth platform or on closely spaced wooden stringers that will prevent undue sagging and keep them out of dirt and moisture.
2. Rods come from the manufacturer in bundles to minimize bending and for convenience in handling. Leave them bundled until used.
3. Thread protection as supplied by manufacturers must not be removed until rods are made up.
4. Protect rods from weather to prevent rusting.

### TRANSPORTATION OF RODS

1. In hauling rods, be sure the ends do not drag on the ground.
2. To unload rods, lift them off the truck and lay them down. Never drop them.
3. Unload rods on flat, clean platforms or closely spaced wooden stringers that will keep them out of the dirt and avoid excessive sagging.
4. Never unload rods where they might be run over by trucks or have heavy equipment dropped on them.

### PULLING AND RUNNING RODS

1. Have threads *thoroughly clean* before making up joints and eliminate subsequent trouble. Use a brush and distillate if needed.
2. Keep slack out of rods while stabbing and avoid cross threading.
3. In making up joints be sure they shoulder. If they don't the threads are dirty or defective.
4. Hammering couplings to break joints is very harmful and should not be done.
5. Excessive pulling to free a stuck plunger permanently injures rods even if it doesn't break them. Better pull tubing than ruin a string of rods.
6. Kinking, bending or nicking rods results in permanent injury. Straightening a bent rod increases the injury. Kinked rods should be replaced.
7. Hanging rods in the derrick instead of laying them down is the best way to keep them clean and avoid mechanical injury. If rods must be laid down, use clean boxes, walkways or racks.

### PUMPING OF WELLS

1. Pump wells no faster than is necessary to get the production. A long, slow stroke is easier on rods than a short, fast one.
2. Use the smallest size pump that will get the production. Large pumps mean heavy loads for rods.
3. Keep rigs in good repair to avoid bumping and jerking which are hard on rods.
4. In wells that are hard on rods use a combination string, as for example, two-thirds of ¾-inch rods at bottom and the top one-third of ⅞-inch rods.
5. Use the loosest pump fit that will pump the oil. Tight plungers not only increase the rod load on the upstroke but cause buckling and breaking of the rods on the downstroke.
6. Provide an adequate counterbalance; avoid pumping with a drilling motion.

*From A.P.I. STDS. No. 11-B, Eighth Edition—A.P.I. Sucker Rod Specifications—Appendix B—Pages 40-41.*

# THE NATIONAL SUPPLY COMPANY

Executive Offices; Pittsburgh, Penna. • General Sales Office: Toledo, Ohio • Division Offices: Fort Worth, Texas; Tulsa, Okla.; Torrance, Calif. EXPORT: The National Supply Corporation, 30 Rockefeller Plaza, New York, N. Y., U. S. A.; River Plate House, 12 South Place, London, E. C. 2, *Limited Liability.*

oil field operations, the Permian Basin instruction centers in the Hearst Memorial Mining Building, one of the finest buildings in the country devoted exclusively to instruction in the mineral industries. Adequate facilities are available for instruction and research in all phases of petroleum technology. The University library is one of the largest technical libraries in the United States, numbering 1,125,000 volumes. Outstanding scientific collections in many fields are available. The Graduate School on the Berkeley campus has in recent years enrolled an average of about 3000 students, one of the largest groups of graduate students in the country. As a result, the University has become an active research center. Many graduate scholarships and fellowships are available for advanced students of superior attainments. The University's Extension Division reaches many thousands of students throughout the West by both class and correspondence instruction.

Berkeley, an attractive city with a population of about 86,000, is but a part of the metropolitan district comprising San Francisco, Oakland, and several other adjoining cities surrounding San Francisco Bay, having a joint population of nearly one and one-half million. Several of the larger oil companies operating in this area have their headquarters offices in San Francisco and the San Francisco Bay region is one of the principal oil-refining centers of the United States. California ranks second among the oil-producing states of the United States, and university students have excellent opportunities to observe and engage in oil-field operations.

**Stanford University.** Stanford University is situated at Palo Alto, California, a city of about 17,000 persons, approximately 30 miles south of San Francisco. Founded in 1885 as a memorial to Leland Stanford, Jr., the University derives its support chiefly from interest on the original endowment funds, student tuition fees, and substantial research grants from various sources. Enrollment is restricted to accord with the facilities available, and in recent years has been about 5200, including nearly 1700 graduate students. Petroleum engineering instruction was first offered here in 1919 as a phase of the work of the Department of Mining. Professor F. G. Tickell, chairman of the department, conducts the petroleum engineering courses.

Stanford University is notable among the institutions specializing in petroleum engineering as the only one requiring six years of academic preparation. Emphasis is placed upon a broad cultural and general science foundation, obtained during four undergraduate years, professional specialization being confined to two following graduate years. The petroleum engineering courses are thus nearly all graduate courses. The School of Engineering has jurisdiction over petroleum engineering students and the degree offered is that of petroleum engineer. During a recent year, 20 graduate students were enrolled in this division.

In an effort to shorten the period of academic training, as a contribution to the war effort, Stanford University has recently adopted a four-year curriculum in petroleum engineering. Whether or not four-year engineering curricula may permanently supersede the six-year plan of instruction at this institution, is not disclosed. Although the desire to provide a strong cultural and scientific background for engineering specialization is a laudable one and has the approval of most educators, as a practical matter it is found that most students do not wish to remain more than four years in college and the graduate engineering courses suffer by lack of patronage. Engineering students tend to gravitate toward the four-year colleges. Prior to adoption of the six-year plan of instruction, Stanford had four-year engineering curricula, and many of her alumni graduated during this period have attained prominent places in the petroleum industry. Nevertheless, probably as a result of the six-year plan of instruction, Stanford University is noted for the high quality of her academic training, particularly in the graduate school. The graduate school of business administration attracts many, among them students whose undergraduate training was in the field of engineering.

Situated on the fringe of the San Francisco metropolitan district, students at Stanford enjoy proximity to urban advantages, yet are sufficiently remote to be free of its inconveniences. For petroleum engineering students who desire industrial contacts, the important oil and gas fields and refineries of central California are but a few hours distant by automobile.

**University of Southern California.** The University of Southern California is located in Los Angeles, in the midst of a metropolitan center having a population of about 2,900,000. Supported largely by private endowments and student tuition fees, the University was founded in 1879. Petroleum engineering instruction was initiated here in 1927. Professor J. F. Dodge is professor of petroleum engineering, assisted by D. L. Roberts. D. H. Larson, J. E. Sherborne, and E. Trostel are lecturers in petroleum technology courses offered as a part of the "University College" program for evening, part-time students. A substantial program of petroleum technology courses is offered, dealing with various aspects of oil-field exploitation. In addition, Professor R. E. Vivian, acting dean of the College of Engineering and professor of chemical engineering, conducts courses in petroleum refining and utilization. The Petroleum Engineering Department, with several other engineering divisions, is housed in a recently completed Engineering Building.

Recently 6800 full-time students and 5300 part-time students were enrolled in regular sessions. The summer session attracts another 6300. Situated in an important oil-industry center, a substantial percentage of the students enrolled in the College of Engineering are petroleum engineering students. In a recent year, there were 75.

Students in this University enjoy the advantages of close proximity to important oil-field and refining operations. Some of the major fields and refineries of the Los Angeles Basin are but a few miles from the University campus. One of the principal oil-industry centers of the United States, Los Angeles is the headquarters for many of the oil companies operating in this area, oil-industry service organizations, and manufacturers of oil-industry equipment.

**Other petroleum technology schools and colleges.** No review of schools and colleges specializing in the field of petroleum technology should fail to mention a few other well known institutions, which, though they do not offer petroleum engineering curricula, yet are doing important work in this field. The California Institute of Technology at Pasadena, California, is one of these. Here Professors W. N. Lacey and B. H. Sage and others in the Department of Chemistry, supported by American Petroleum Institute funds, have conducted notable researches in the field of fundamental properties of hydrocarbons. At the University of Michigan, Ann Arbor, Michigan, Profesors F. E. Bartell and G. G. Brown of the Chemistry and Chemical Engineering Departments, respectively, are making notable contributions in the field of petroleum technology. Massachusetts Institute of Technology at Cambridge, Massachusetts, and Rice Institute at Houston, Texas, are also well known technical schools where many engineers prominent in the petroleum industry have received their training. Some of these institutions offer excellent opportunities for graduate training in special fields for petroleum engineering students who have had their undergraduate preparation in other schools.

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**WITH 100% COOPERATION**
**AXELSON CAN KEEP**
**YOUR WELLS PUMPING**

# *Shortages of Critical Materials Means Substitution . . .*

There is a difference between substitutes and substitution. Substitutes may not be as good as the original, but substitution may sometimes be better.

During the coming months, Axelson is requesting your cooperation in the matter of substitutions for various pump parts.

Although the oil industry is recognized as vital to the war effort, at present much of the steel that would ordinarily be allocated to equipment manufacturers later is now being used in ships, tanks, and guns.

Axelson's facilities are still available for the manufacture of pumps and sucker rods. Lack of material, even with high priorities, is the only thing which has forced a curtailment of production.

Remember Axelson is no more anxious to make substitutions than you are to have them made, for in many instances these substitutions cost more money. As far as Axelson's substitutions are concerned, you can depend on the job they will do in maintaining the standards of quality and performance that have been traditional for over fifty years.

**BY WAY OF EXAMPLE HERE ARE A FEW SUBSTITUTIONS...**

**SEATS AND BALLS**

When you and we have exhausted present stocks of stainless steel seats and balls, there won't be any more for the duration. That's going to mean the use of carbon steel and certain steel alloys, as long as they are avaliable. Until a few years ago, carbon steel seats were regarded as entirely satisfactory by the majority in the oil industry, and only through hard selling was Axelson able to introduce stainless steel. Even now, some operators question the advantages gained when used under certain conditions. Seats and balls are one place where substitutions will hit first. It is highly possible that an improved seat and drop may be substituted in alloy or other steels when available.

**LINERS** In their own foundry, Axelson produces grey and alloy iron liners of several types. Up until the present time Axelson has experienced no difficulties in producing these type liners. If conditions arise, where shortage of steel becomes more acute, and forcing a shortage of steel liners, we hope to have a *complete line* of iron liners which we know will produce oil to your satisfaction.

**PLUNGERS** Not so many years ago, cup plungers were regarded by some as superior to any other type. Gradually, Axelson's metal to metal principle has been accepted by the industry together with various refinements in plunger design.

It is entirely possible that as present plunger stocks are exhausted, operators will be asked to accept other types of plungers that will render good service, although their wearing qualities may be slightly less than that of the plungers they supersede. These new designs to be of a high quality wear-resisting iron or other materials.

Rest assured that Axelson will continue to furnish the highest quality of plungers commensurate with the steel stocks available.

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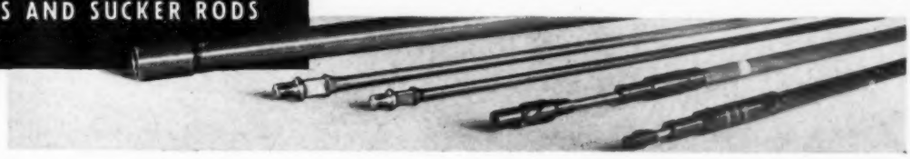
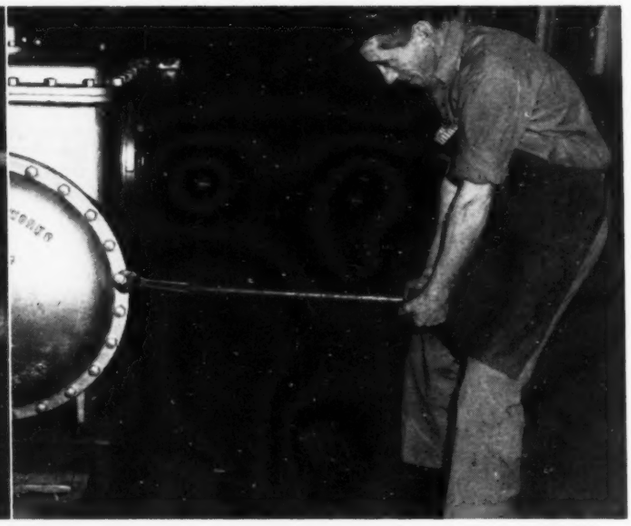


*The right wrench for the job is the safe way to work*



*A "cheater" is unsafe. It ruins the tool and may lead to an accident*

# Safe Practices in the Natural Gasoline Plant

PETROLEUM ENGINEER Exclusive Feature

☆ **Elimination of dangerous conditions, and observance of safe practices by workmen, contribute importantly to efficient plant operation**

*by Don Attaway*

**Safety Engineer, Arkansas Fuel Oil Company**

*Photographs by J. E. Hampson, Arkansas Natural Gas Companies*

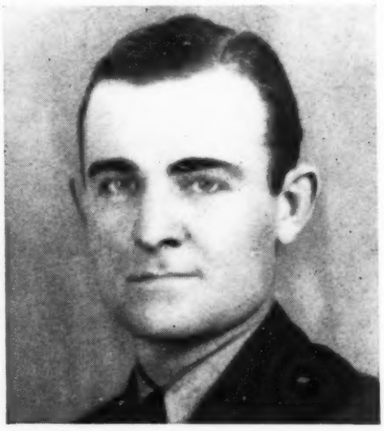
FROM the safety engineer's standpoint, there is no difference in operation and safety. These two fundamentals so overlap that it is impossible to distinguish between them. All accident prevention can be said to have seven basic factors, as follows:

1. Proper design and layout of equipment.
2. Proper mechanical guarding and maintenance of equipment.
3. Selection of men physically and mentally fit for the job.
4. Development of safe practices for the different jobs.
5. Instruction of men in correct methods.
6. Close supervision to insure safe working procedure.
7. Provision and use of suitable protective equipment.

Therefore, we might say that for a large part, safety is recognizing the hazard and correcting it. In full it is a matter of knowing *what* to do, *how* to do it, *who* should do it, *when* to do it, *why* it is done, and *where* it can be done. It would seem that the "how" and "why" of safety carry the most weight, so for information on this matter let us apply our fundamentals and take up the first factor, which is design and layout, and see what safety practices may be incorporated.

## Design, Layout of Equipment

The one ever-present hazard in a natural gasoline plant is the boilers—a source of ignition for fire or explosion. The boilers should be placed on the highest ground on the plant site and on the windward edge. The reason is almost self-explanatory. In case of a broken line or ruptured vessel, the inflammable liquid or gas would not gravitate or likely be blown by the wind toward the boiler burners. Some constructors favor placing the cooling tower between the boilers and storage tanks. Most modern plant layouts include remote shut-off valves for emergency use.



**DON ATTAWAY**

began his career with the Dixie Gulf Gas Company as timekeeper in the Waskom district, January, 1928—Entered the payroll department of United Gas Company late in 1929 and worked there until he accepted a position with Arkansas Fuel Oil Company in September, 1930, in the gas accounting department—Worked successively as meter man, loading rack man, and utility man in the East Texas natural gasoline plant—Later was transferred to the Shreveport gasoline plant—In January, 1940, he was made safety engineer for the company—His headquarters are in Shreveport, Louisiana.

The storage tank battery should, of course, be placed on the lowest point in the plant site and an adequate fire-wall erected around the battery. The separation of vapor source from ignition point explains this feature. A good safety practice is the connection of all storage tanks near the top into a common header. This provides for the use of all the relief valves in case vapors begin building-up pressure faster than one safety valve can handle them. A serious hazard exists in not realizing that relief valves should be designed for liquid pressure as well as vapor pressure. A high-pressure pump filling a storage tank can easily rupture it, if the relief valve cannot handle the liquid volume discharged by the pump when the tank has become full.

The location of the engines in a compressor type plant is most satisfactory when good foundation is found on the downwind side of the plant. These compressors should be equipped with short-circuiting devices to operate in case of governor failure, abnormal jacket water temperature, or low oil in lubricating system. Suction lines to the compressors should be provided with adequate scrubbers to remove liquid that might enter the line. In casing-head plants, this is especially important in view of the fact that oil-well separators may "hang-up" and cause crude oil to pass into the gathering lines. In such cases, the scrubbers should be fitted with an alarm and automatic shut-off to prevent the "blowing" of a cylinder head. The drains to the scrubbers should be sufficiently large to handle excessive amounts of liquid.

Special attention should be given the air-starting system in the engine layout and the air compressor should be two-stage, if possible, to reduce the heat of compression. The line to the air reservoir should have a mist extractor and the receivers should be equipped with drains at their lowest point. It is good practice to install two check valves in the air-starting piping to each engine to provide protection against hot pieces of burning carbon or ignited gases from escaping through a leaky check and firing any gas mixture that might have leaked through.

*The wrong way to use a screw-driver. A slip may mean injury to the hand or knee*

Compressor buildings should be ventilated at both floor level and roof to prevent the accumulation of any vapors that might be ignited by the magnetos, engine back-fire, or static electricity. Each engine room should have two or more exits with doors opening outward. A good practice is to allow one door for each additional engine installed after the third engine. The air intake to engines should be outside the building to prevent vapors entering the cylinder in case of a broken line.

Piping aboveground is the most economical in the long run and in this day of harder dies, improved fittings, and better welding methods, all leaks can be eliminated. Several serious plant fires and explosions can be traced to badly corroded make-lines and weakened high-pressure discharge piping that was covered with earth and the true condition unknown until after the accident.

The safety problems of the distillation unit, stabilizer, and absorbers are usually taken care of in original design and their location determined by the site of the engine room and boiler house. From an economy as well as safety standpoint, any difference in plant elevation can usually be utilized to eliminate some of the pumps required as movers.

Although no attempt is made here to cover completely the aspects of proper plant layout and design, these points shed ample light on the importance of such consideration.

## Mechanical Guarding

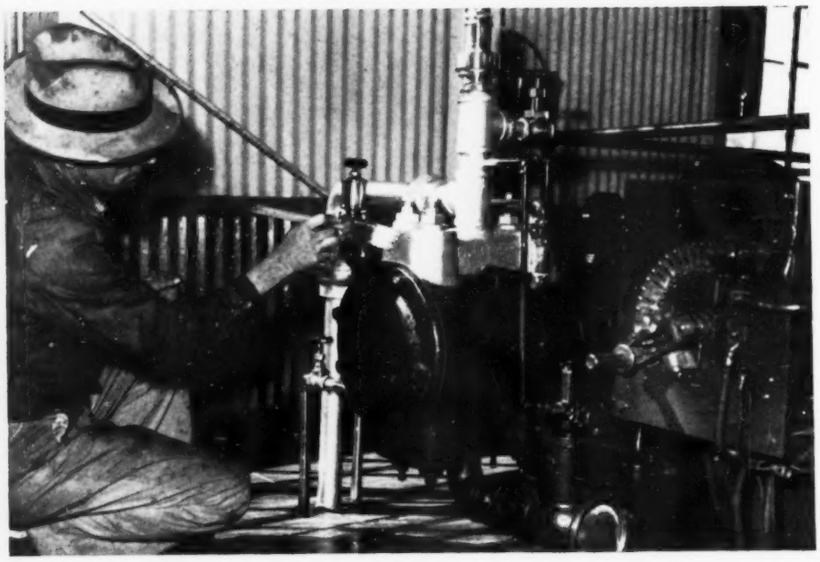
The second factor, that of mechanical guarding, means more than placing heavy wire cages around flywheels and screen guards over high-pressure gauge glasses. We must take into consideration such items as relief valves on stills, accumulators, air receivers, and surge tanks. Each valve should have a vent for rapidly dissipating vapors and these vents should be equipped with an opening at the lowest point to prevent water from collecting. Care should be taken in placing the relief valves so that they do not discharge toward a possible point of ignition. Open gate-valve boxes should have covers and stairways should have handrails. Grinding wheels and emery stones should have cases, and cranks on gasoline engines should be chained or fixed so that they cannot fly out and strike the workman.

Proper mechanical guarding would also include boiler installations, which must comply with the State code. Automatic feedwater and firing devices are economical and a good safety investment.

## Maintenance of Equipment

Proper maintenance of tools is just as important as repairing the equipment. Handles should be sound, firm, and free from splinters in all shovels,

*Keep tools in their proper place. A neat rack means a safe place to work*



*Paint up. It preserves materials and adds to the pleasantness of the surroundings*

hammers, picks, sledges, and axes. Chisels should be kept free of burred heads. Pipe wrenches require heel and jaw replacements to prevent slippage and open-end wrenches that are sprung or broken should be discarded. A "cheater" should never be used. It is best to get the proper size tool for the job.

Proper maintenance means all this as well as good housekeeping and the regular inspection of pumps, engines, controls, lines, tanks, and vessels for any evidence of strain, weakness, or overload that could cause trouble. The time to prevent the accident is before it happens. Leaks should be stopped as soon as they appear. Knocks can be silenced as soon as they are heard.

### Selecting Workmen

The problem of man selection is entirely in the hands of the management or superintendent. We know that it is an injustice to hire a man for work that would aggravate any physical handicap or ailment that he might have, and it is decidedly unfair to employees to hire a man with a communicable disease or physical disability that might endanger them. An examination by a competent physician previous to employment is a safe practice.

The development of the safe working procedures for the different jobs comes as a result of compete knowledge of the equipment and experience in its operation. Basically all gasoline plants operate along a general routine, but any experienced operator will tell you that each installation has its own peculiarities or "hot spots." To become an operator, a man must possess certain important qualifications before he can justify the investment of the company in training him. In addition to being healthy and mentally alert, he should possess some natural mechanical ability. He should have an even temper and good courage. A knowledge of the laws of physical science is important. Generally a man with as little as a high school education who begins as a plant laborer and learns the essentials of pipe-fitting, plant construction, engine repair, general equipment operation, and layout, makes good material for a plant operator.

### Instructing the Workman

The instruction of this man in correct and safe procedure begins with his first day on the job. The good foreman will take his "green" hand and explain the "how" and "why" of each job or operation as they go along. The fellow workers, operators, and superintendents contribute to this man's training by pointing out the correct use and care of hand tools, precautions in welding, handling and storing of material, use of safety devices, fire prevention and fighting, and good housekeeping.

For specific practices, let us take the work of welding. This work involves hazards such as injurious light rays on the eye, foreign objects in the eye, burns, and even more serious—explosions. Any work in welding automatically demands the use of goggles. Cutting and welding on tanks should only be done after they have been steamed for 12 hours or more. In steaming the tank, the hose should be grounded to the vessel to prevent static, and the covers or openings removed so that good purging is obtained. After steaming-out, the vessel should show a negative test on a gas or explosion tester. Welding on pressure lines should never be attempted until the pressure has been reduced to slightly above atmospheric. In the case of vacuum lines, the line pressure should be raised slightly.

Other safe practices include the explanation that removing burned-out light bulbs without cutting off the circuit can cause an arc that will ignite vapors. Men have learned to their sorrow that gasoline cannot be used as a cleaner, and should be closely supervised to prevent other misuses of gasoline. Breaking men of the habit of smoking on the job is difficult, but most imperative.

After a period as handy man at the plant, the employee begins a term of two years or more as a repairman helper, oiler, or relief boiler fireman. In this work he acquires the safe practices of boiler operation, which teaches him always to maintain proper water level in the boilers, frequently check gauge glasses by blow-down, and never stand directly in front of a fire-box to light the burners but to open the valve slowly from a safe point. He learns that a quick-opening boiler blow-off valve must be closed with a slower action to prevent the surge against the throat sheet and that all operating points and parts should be carefully checked when going on or coming off duty. He learns to report any and all faulty conditions; never to enter a boiler without being sure that water, steam, and fuel lines are closed, blanked, drained, and marked with a "Danger" signal; to put boilers back into service slowly and open steam valves with care. By the same method he learns that shutting boilers down slowly and gradually reducing steam pressure prevents undue strain upon metal, rivets, fittings, and pipings.

As a repairman helper, the employee will learn that in starting engines, fuel should not be admitted before the ignition is turned on, as these unburned gases could collect in the exhaust system and cause a serious explosion. He will learn that engines should be turned over by hand or jack after being repaired to be sure that no forgotten tools or parts were left in the mechanism. He will be taught never to trust gate valves as a positive shut-off and many other little safety details that the foreman, chief repairman, or superintendent have developed as safe practices on the particular job.

When the employee has learned the "how" and "why" of the mechanical hazards involved in a plant, he has acquired the foundation for a good operator and is more capable to understand the operating procedure.

The heart of a gasoline plant is the distillation unit. The efficiency of the plant as well as the quality and quantity of the finished product depends to a large extent upon the care and attention given this one unit. Accord-

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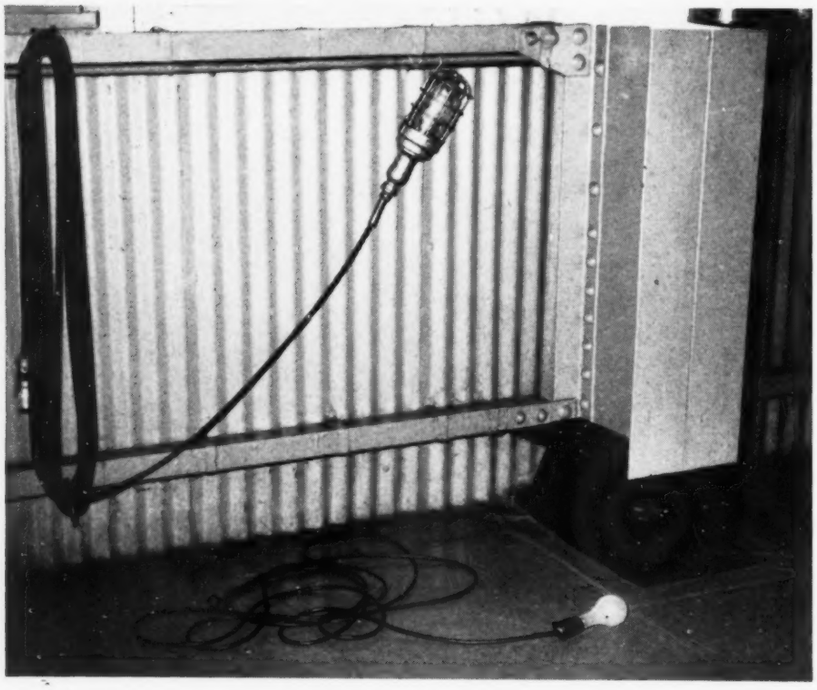

*Take care of equipment. Electric cords are as dangerous as snakes unless they are handled with care*

ingly, a good operator is able to detect and spot difficulty or likely trouble before it happens by close attention and proper operating practices. The following is an example of the routine for an alert operator:

1. See that loads are evenly distributed between units.
2. Make sure oil delivery to heat exchangers is uniform and free from water and emulsion.
3. Check controls to see that uniform oil delivery is regulated to preheaters.
4. Watch for all signs of leaks.
5. Check steam system to preheaters to see that condensate is being delivered to return system.
6. Be sure that all liquid-level controls are working.
7. See that oil delivery to stripping still is uniform and that no water accumulates in still.
8. Be sure proper amount of live steam is admitted to still and that pressure is constant and as low as possible.
9. Watch top temperatures and keep them constant by uniform reflux delivery.
10. Check traps, scrubbers, and separators.

Attention to the recording and indicating devices on the distillation unit enables the operator properly to identify the difficulty. Let us take the recording thermometer on the still and note the conditions that might be indicated by its behavior.

1. Irregular flow of oil
2. Leaky preheater
3. Contaminated oil causing emulsion
4. Priming boilers
5. Defective water return system
6. Change in gasoline content of gas treated
7. Improper vent tank operation
8. Poor reflux control
9. Gas-locked preheaters
10. Boiler pressure low
11. Defective liquid-level controls on absorber or still.

Selecting certain of these troubles, such as a defective liquid-level control, we might find that a vent tank will be caused to overflow, creating a serious fire hazard. Poor reflux control can cause the still relief valve to open and saturated vapors will spread over the plant, creating a serious hazard.

## Protective Equipment Essential

Undoubtedly safety and operation go hand in hand with the plant operator, but certain of his duties are of such nature that he must require special protective equipment to perform them. Employees could hardly be expected to fight a plant fire without the proper equipment. Neither can they be expected to use a hammer and chisel in a place suspected of holding flammable vapors unless the tools were of spark-proof construction. Among the equipment that should be in every gasoline plant we can list gas masks, goggles, dead-weight testers, gas testing devices, non-sparking tools, respirators, salt tablet dispensers, first aid supplies, etc.

This equipment should be available at the point it is most likely to be used; for example, the goggles belong at the grinder, emery wheel, and welder's bench. The fresh-air mask is used mostly at the loading rack or storage tanks. The tool board should hold the non-sparking tools properly identified and designated.

Protective equipment is of no value unless it is used and the men should be instructed and encouraged in its utilization until they have formed the habit or practice of never attempting work involving an exposure hazard without protective devices.

## What to Do in Emergency

The final point of safety as applied to natural gasoline plant operation practices concerns what to do in case of an accident. Certainly being calm is difficult, but the operator must realize that anything he does must be for good reason. In case of fire, the first impulse of the operator is to shut down the plant. This could be a most serious mistake. Let us suppose a tank overflows and catches fire. Perhaps the fireman will cut his boiler fires. This action would be for no good reason. Steam pressure would decline. Circulating pumps would stop or slow down. Stills would pop and temperatures rise on condensers. The possibility of more tanks overflowing or tubes in direct-fired preheaters rupturing would only add to the problem. The best practice would be to stop the flow to the tank and attack the fire with foam or chemical fire carts. Perhaps live steam might be needed to smother the flames and certainly a boiler station shut down would not help.

One case reported concerns a blown gasket on the rich oil line to a heat exchanger. Quite a puddle of oil caught fire under the exchanger and an intense heat enveloped it. The operator stopped the rich oil pump and as there was no circulation to help carry off the heat, a flange cracked and the full flow of oil made a fire that could not be extinguished with the equipment on hand. A good operator would have immediately brought a fire extinguisher into play and left the oil pump alone, unless he desired to reduce the amount of the leak by slowing down the pump.

Every natural gasoline plant should have one man to devote a considerable part of his time to safety. He should consult and discuss with operators their working procedure. He should take steps with the management to see that dangerous conditions are eliminated and safe working practices instituted as a part of economical and profitable plant operation.

☆ ☆ ☆

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Vocational Class Proceedings in Refinery Engineering

## Manufacture of Lubricating Oils

### CLASS MEETING NO. 1
(Continued)

*Leader:* Was that enough on the point just brought up? There is another characteristic in regard to viscosity, and that is the viscosity-gravity constant. What does that mean to you? There is a relationship between this and viscosity index number, so it will be observed that the viscosity-gravity constant is inversely related to the viscosity index number and it makes a very ready means of identifying the sources of oil involved. When the Oklahoma City field was first brought in, a 5-gal. can of crude oil was taken to a company laboratory and a request made for quick evaluation. After making a distillation test and taking the gasoline overhead and completing the residue and flash, a quick evaluation was made: it appeared to be a crude excellent for lubrication. That was by means of using the same viscosity-gravity constant as here. So this little measure is very handy.

*Pupil:* The spread between flash and fire is greater in the case of Pennsylvania oils than it is for Gulf Coast crude oil and can be used as a rough method of identification.

*Pupil:* Lube plant stillmen use viscosity gravity constant a great deal.

*Leader:* Yes, but they use it unofficially, don't they?

*Pupil:* Yes.

*Leader:* So that is another handy tool to give you some idea of the types of hydrocarbons that are employed. What type of hydrocarbon should we say is predominant in that group?

*Pupil:* Asphaltic.

*Leader:* Are there any questions on viscosity-gravity constant? Does anybody have any question on carbon residue before we pass on? Do you realize what some of the values are, do you have it well enough in mind?

*Pupil:* I should like to see some typical values.

*Leader:* All right, let us say we were talking about SAE 20. We are going to talk about our own oil. Suppose they were made from naphthenic oil, what would the value be?

*Pupil:* As low as 0.12, I would say.

Leader writes the following table on the blackboard:

| | *Carbon residue, percent* |
|---|---|
| Mid-Continent SAE 20 | 0.24-0.48 |
| Gulf Coast SAE 20 | 0.10 |

*Leader:* Used in an engine, which of these oils would carbonize to the greatest degree?

*Pupil:* I don't think there is any way to tell except by using the oils in an engine.

*Leader:* Let us say this is just a rough index then.

*Pupil:* When comparing two oils made with the same type of blends, blends made from the same class of base stocks have quite a bit of different carbon residue and when you get up to SAE 40 it is even more marked, and yet the viscosity is the same though the carbon residue is not.

*Leader:* The question was, does the variation in carbon residue serve as a quality index? Would you be willing to accept the belief that one oil forms carbon worse than the other?

*Pupil:* Yes. You have to know not only what the base crude is, but what the base blends are before you can say one will give you a greater carbon residue than the other or be more harmful.

*Leader:* You would be inclined to believe that you have a complicated problem. What would you think about these optical indices? Would you think an index of refraction has any value to us?

*Pupil:* As a means of identification.

*Leader:* They are so close together that it seems of rather doubtful value.

*Pupil:* I believe the author of our text does state that the public erroneously considers carbon residue as harmful, whereas he says some of it is beneficial. Pure carbon protects from acid and corrosion and erosion.

*Leader:* We might have an oil that won't make acid.

*Pupil:* We might draw it in through the intake.

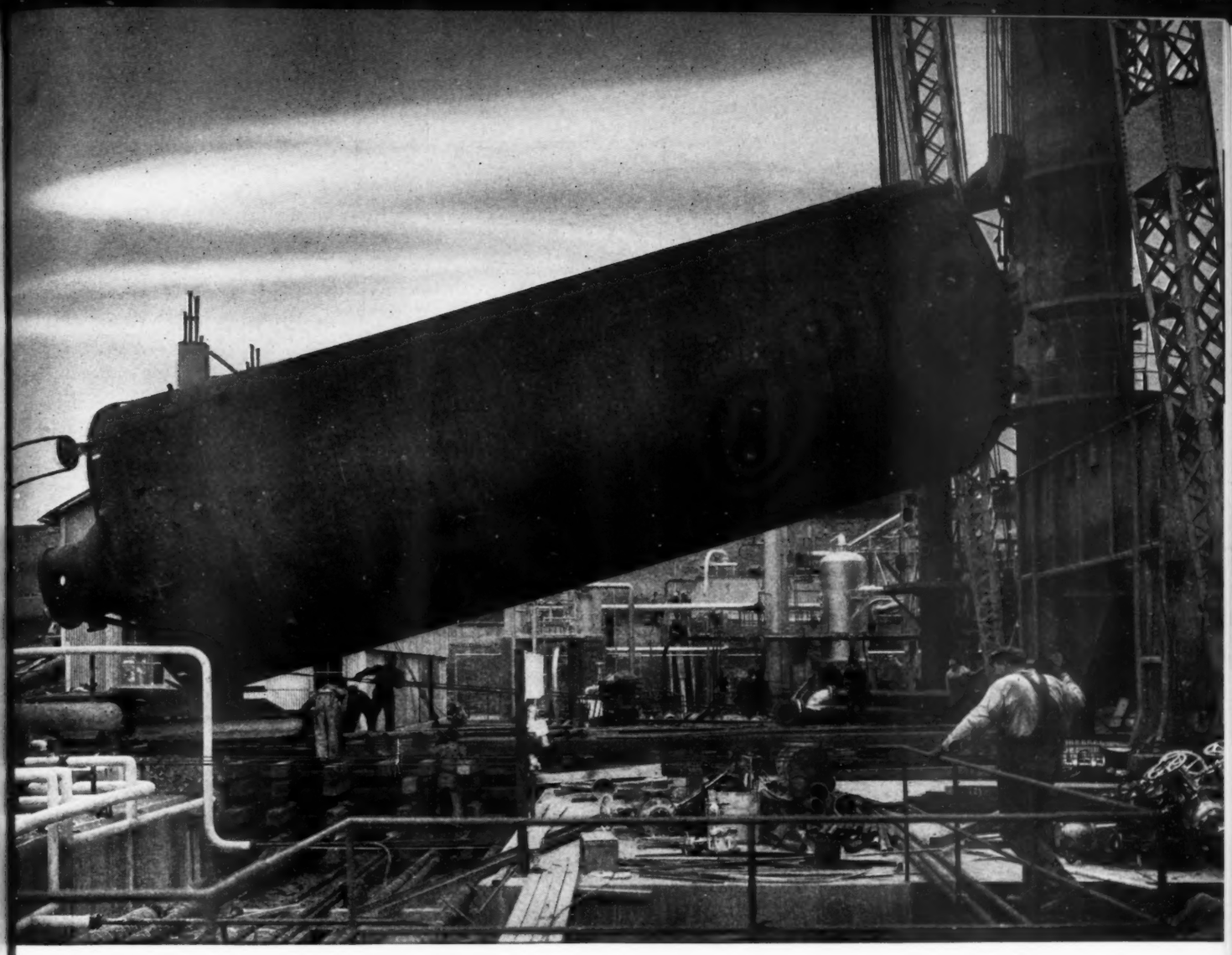
*Pupil:* Is there a possibility that the carbon coating would tend to eliminate the metal, acting as a catalyst and causing further oxidation of the oil?

*Leader:* That is an interesting point and I should appreciate it if someone would attempt to supply an index of the value of lubricating oil. What value would we get out of the optical activity? Does anyone have information on that point?

*Pupil:* I think it is just a means of identifying some additional facts. Concerning oxidation stability, there is some disagreement about the method of its determination. We are using the Indiana Oxidation Method. Can anyone give us a statement about that in brief?

*Pupil:* The Indiana Oxidation Test is conducted at 341°F. An oil-bath is heated to that temperature, which is supposed to be the average engine temperature. A given amount of oil is measured into a clean glass test tube and air is admitted to the oil and measured through an orifice meter. The rate of oxidation is measured by taking samples of the oil at various time intervals. The samples are diluted with naphtha and the amount of sludge is weighed in a Gooch crucible. This has its disadvantages and you are probably aware that some sludge is not retained by the filter. The evaluation is measured by the number of hours that it takes 10 mg. of sludge to form in 10 grams of oil, or the number of hours it is required for the oil to attain a neutralization number of 1. These values are obtained by plotting the results from the samples taken on log-log paper.

*Leader:* (Exhibits sample) This is one of the oils that we have used. This has about ⅜ in. deposit of sludge in the bottom, and though it does not necessarily indicate that the oil has failed, it is something to be reckoned with. Here is a sample of a product that contains considerable sludge. This is from one of the engines of a refinery, a 6-cylinder engine used to drive a welding machine. Some of these soft, flocculent sludges do not do much harm. I have had one engine that has been driven 22,000 miles and another 27,000 miles without any repair work whatsoever and no increase of oil consumption, indicating fairly good lubrication, using these same oils containing



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sludge. I have had some oils that were worse. When you drain the oil from your car, it has a turbid appearance. There are solids in there regardless of sludges, so with a filter on the car much of the sludge is taken out of circulation.

*Pupil:* Although the amount of sludge may be an index of the bad qualities of an oil and the sludge is filtered out, the oil can still deteriorate to the point of not lubricating, although it shows no sludge.

*Leader:* That is right.

*Pupil:* Except for the possibility of a clogged oil line, the new filters on automobile engines now may be doing more harm to the average motorist than good, because he may think he has a good oil when he hasn't.

*Pupil:* We might mention that work is being done now on some improved methods of rating oil from the oxidation standpoint, and that the Indiana Oxidation Test is more or less out of date.

*Leader:* That is one school of thought. We want all; there are still many different ones. One group wants to modify the Underwood machine and another group to adopt the method used in Detroit.

*Leader:* Mr. Jones, of The Continental Oil Company, gave a very excellent paper on the test method being used with the modified Underwood machine.

*Pupil:* Is that a routine method being used?

*Leader:* I think so.

*Pupil:* It seems to me a fleet test would be the best kind.

*Leader:* I always like to make a laboratory test and then run fleet tests to check.

*Pupil:* Isn't a lot of different work being done now on oxidation of oils tending more and more to the point where there will be a greater value in the reclaiming of oil, as well as making an oil? It may be we shall reach the point where the value of lubricating oil is so great that in order to carry out a so-called conservation program we shall also have to consider what oils should be saved and what can be done to bring them back to their original state.

*Leader:* That wasn't the objective.

## Class Meeting No. 2

*Leader:* Last meeting we discussed the subject of what made a good lubricating oil, or what the customer would want from the standpoint of use in an internal-combustion engine. I think we will all agree that an internal-combustion engine has needs that some lubricants will not necessarily supply, but as internal-combustion engines are using the greater part of the lubricants made, the general discussion will assume that this is the type desired. In looking at the relative merits of acid treating and solvent treating, the examples are given by the author of our text on SAE 60 oil when refined under several different conditions. I should like to ask some of you to help fill in this column. This is a matter of copy and is information found on page 25 of your text (Table 1). One is a 1932 typical Mid-Continent refined oil with a gravity of 23.7 and one is a solvent-treated oil with a gravity of 28.0; a good many things have evidently been removed. On Pennsylvania 1932 percolated oil we find a gravity of 26.2. One means consistently used to identify the source of an oil is its gravity, so you see how solvent refining upsets the ordinary way of determining the source of an oil. We come along with current production and take Pennsylvania oil, solvent extract, and finish by percolation filtering. We find the gravity increases to 28.5. That is somewhat higher than all of them, so if processes are similar, we still have some of that same trend. The pour point perhaps is not so important in trying to show up the process, but it is given as a matter of information. So far as I can see, there is no reason why these two should not be the same. Will someone tell us the gravity on vacuum-distilled, acid-treated Mid-Continent oil that may be treated in this part of the country?

*Pupil:* About 25.

*Leader:* The pour point would be about what?

*Pupil:* Zero.

*Leader:* Now flash; 480 was the typical flash for acid-treated Mid-Continent oil, whereas refinement of solvent-treated Mid-Continent oil is 515. How about SAE 60 Pennsylvania 1932 oil?

*Pupil:* About 500.

*Leader:* In the table we find that the Pennsylvania oil of older vintage is about 510 and Pennsylvania solvent-refined is 540.

*Pupil:* Wasn't 515 all right for the solvent-treated oil?

*Leader:* Yes. The fire point is 535 for acid-refined. What is it for Mid-Continent solvent-refined oil?

*Pupil:* About 585.

*Leader:* Mid-Continent solvent is 585, old Pennsylvania 575, and new 610. The viscosity of 1765 seconds at 100°F. for acid-treated Mid-Continent oil and 1437 seconds at 100°F. for solvent-treated oil compare with 110 seconds at 210°F. for both oils, so now we see what happens to the viscosity curve when it is solvent-treated. A lesser but definite improvement of the viscosity-temperature slope also occurred with the Pennsylvania oils when solvent-treated. The viscosity index number is 80 for acid-treated Mid-Continent oil and 98 for solvent treated. The Pennsylvania oil before being solvent treated was 98, or it may have been 100. This was not so heavily solvent treated as some and came out 105. Carbon residue is 1.4 and 1.5 for the 1932 oils.

*Pupil:* I would have said 1.5 on the 1932 oil and 0.98 on the present.

*Leader:* Solvent-treated Mid-Continent at 0.3 percent shows a very marked change, whereas the Pennsylvania, instead of being low, came out 0.4 percent. That has been a typical trend. Solvent-treated oil still is slightly higher than Mid-Continent. The Slight oxidation number was 4 for Mid-Continent oil in 1932. Pennsylvania was 1, and both solvent oils are zero. All this then tells some kind of a story: the relative merits of acid treatment as compared with solvent treatment. Would you say that acid-treated oil would be superior for an internal-combustion engine? Suppose you wanted to get color, is there any advantage there?

*Pupil:* Yes. The advantage of making the same color with far less loss.

*Leader:* Why?

TABLE I

S.A.E. 60 motor oils

| | 1932 | | 1937 | |
|---|---|---|---|---|
| | Acid refined Mid Continent | Percolated and Dewaxed Pennsylavnia | Solvent refined Mid Continent | Solvent refined, percolated, and dewaxed Pennsylvania |
| Gravity, deg. A.P.I. | 23.7 | 26.2 | 28.0 | 28.5 |
| Pour point, °F | 25 | 20 | 5 | 0 |
| Flash point, °F | 480 | 510 | 515 | 540 |
| Fire point, °F | 535 | 575 | 585 | 610 |
| Viscosity (Saybolt Universal) at 100°F., sec | 1,765 | 1,736 | 1,437 | 1,543 |
| Viscosity (Saybolt Universal) at 210°F., sec | 110 | 123 | 110 | 122 |
| Viscosity index | 80 | 98 | 98 | 105 |
| Carbon residue, percent | 1.4 | 1.5 | 0.3 | 0.4 |
| Color (Lovibond) | 240 | 300 | 80 | 30 |
| Sligh oxidation No. | 4 | 1.0 | 0 | 0 |

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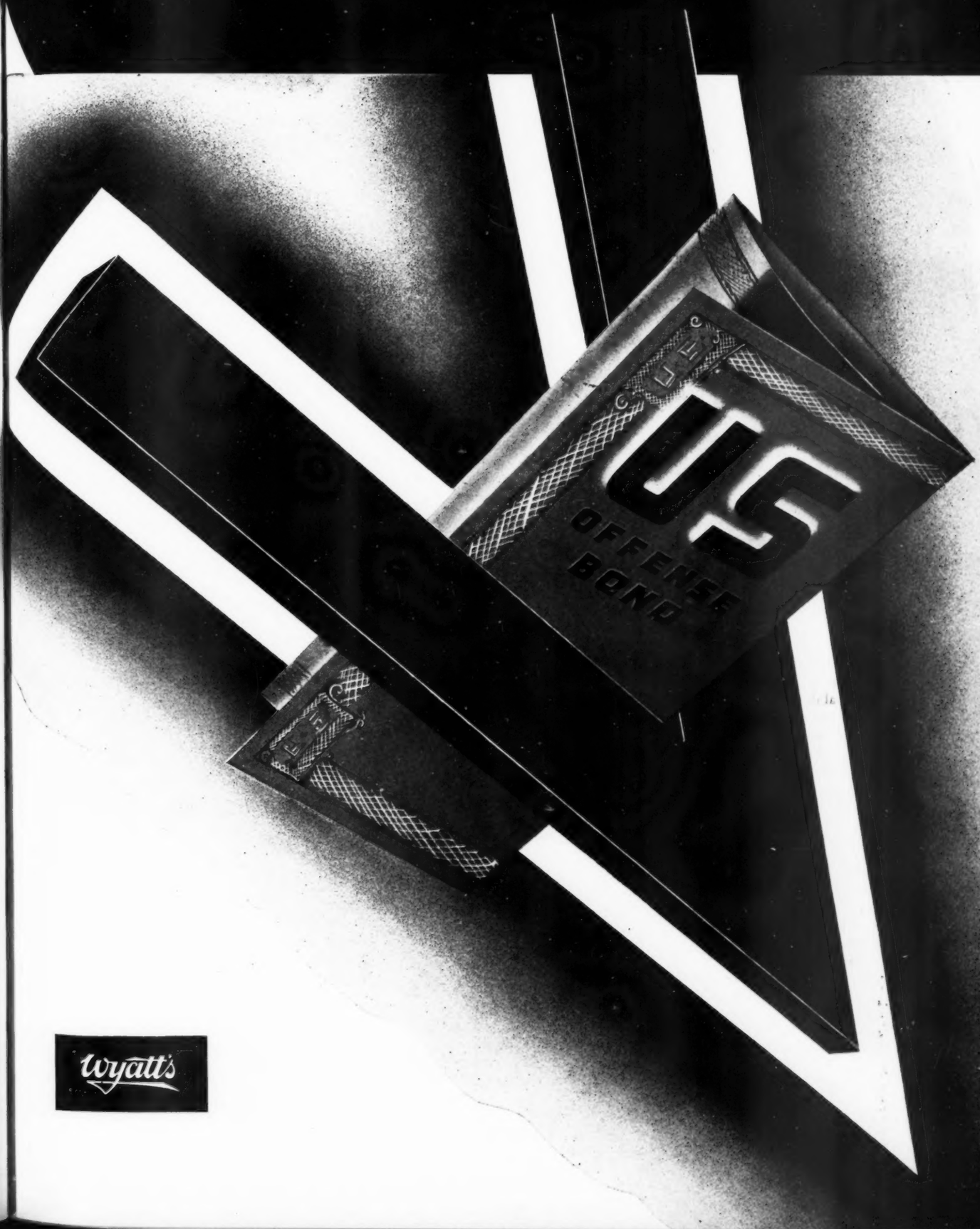


Wyatt's

*Pupil:* Because when oil is acid treated, one of the things that the acid immediately attacks is the impure carbonaceous material. These impurities are the cause of the dark color. In a solvent treat the coloring materials tend to remain in the raffinate and therefore a much heavier treat is necessary to remove them, consequently the losses are higher.

*Leader:* The advantage in color seems to me a rather shallow point to discuss.

*Pupil:* I think it is a price consideration; it is cheaper.

*Leader:* Suppose, due to the price consideration, journal lubrication, and some of the red engine oils, that a solvent-treated oil is not justified; then what will the answer be? Will there be room for some refiners to make acid-treated oils and sell them to refiners that make solvent-treated oils; or the alternate of that? Is it an economic balance?

*Pupil:* If you have a large enough refinery to perform both processes or a large enough amount of equipment, it would pay to acid refine a part of the lube oil in order to fit your products to your demand without undue treating losses and costs.

*Leader:* Off-hand, it does not seem so to me. There is an example given in our text[1] of acid treating at length to produce oils something like solvent oils. The original oil gravity was 21.8 and viscosity was 150 S. U. at 210°F., and 4.3 percent for carbon residue. The viscosity index number was 70. The oil was treated with 98 percent acid and we remember that about 93 percent acid is somewhat of a standard. In this instance sulphuric acid was used. I believe that would be the average treatement, and produced 25.0 A.P.I. gravity, 112.5 viscosity. The viscosity index number came up to 83, the oxidation stability was poor, and a number of changes took place. What brought this viscosity down?

*Pupil:* The gravity went up on account of the tars and resins that were treated-out and the viscosity differential was probably due to some unsaturates from polymerization or condensing reactions.

*Leader:* The carbon residue reflects that same condition. So these also must be the cause of the poor viscosity index number. Let us assume we gave this heavy treatment 98 percent acid, and in addition used a fuming acid, 227 lb. to the bbl., and find that the gravity came up to 30.8. It looks as though the action of the solvent acid was asserting itself and the viscoscity dropped down to 72.2. The carbon residue is zero, so we must have a pretty good oil. The viscosity index number goes up to 105, but there is a fly in the ointment—poor oxidation stability.

*Pupil:* It is too bad we don't know the loss figure.

*Leader:* Yes, it is.

*Pupil:* It is very high.

*Leader:* Let us discuss the economics. Acid costs 1 cent per lb. If you spend 1 cent per gal. and lost ¼ of the oil to sludge, that would bring it up to about 1⅓ cents for treating. That is not excessive. But say you have spent for treating something over 6 cents per gal. on your original gallon of oil, and lost about 65 percent of it. If we ended up with ⅓ of the original volume, then we have to make that charge 3 times as much, or 18 cents per gal. based on the final amount of oil produced, which is decidedly too expensive. Light oils were used for textile lubrication and the consumers did not mind that expense, but for general purposes, even supposing you worked out an oxidation inhibitor, it can be seen that economics are likely to be out of bounds. Is there any question? It might appear that I do not think much of acid treatment —I don't want that misunderstood.

*Pupil:* The reason for excessive losses in treating with large quantities of 98 percent acid is that the acid is applied by several small treatments and quantities of oil are contained in each separate sludge draw-off. The acid used in the last treat will not have as much reaction on the oil as the first treat, but it will carry off some oil.

*Leader:* I think that is very properly explained; however, there is a considerable loss even if you take out the sludges and separate the oils by centrifuge or with solvents.

*Pupil:* Those lighter sludges do not coagulate, making it necessary to draw-off considerable oil.

*Pupil:* The high loss of this extra heavy treat would be a mechanical problem more than anything else. If it could be separated, it would not be so bad.

*Leader:* It might be better, but is still rather costly.

*Pupil:* That picture is on acid treating of bottom stock, isn't it? Would it be better for vacuum distilled stock?

*Leader:* It would be much better.

*Pupil:* Isn't it rather important how close your fractionation comes to eliminating asphalt in its relationship to volume loss and costs of acid treating?

*Leader:* All the work that has been done shows a better economic picture.

*Pupil:* You are no better off beginning with vacuum still products than with a residual stock.

*Pupil:* It has been said that acid removes asphalts, unsaturates, tars, and resins, and yet you still have poor oxidation stability. Why?

*Pupil:* You treat out some of the natural inhibitors.

*Leader:* Yes. Are there some other questions?

*Pupil:* I think a certain amount of acid remains in the formation of soaps, etc., which are very readily oxidized.

*Leader:* I think that is one of the biggest reasons.

*Pupil:* Acid really works on natural inhibitors.

*Leader:* I am not so sure.

*Pupil:* I was of the opinion that the caustic wash was what took care of the natural inhibitor rather than the acid treat.

*Leader:* I don't know the answer to that. (Caustic would remove phenolic groups.)

*Pupil:* What are these natural inhibitors and what has been done about them?

*Pupil:* I have heard considerable talk about natural inhibitors, but I have never heard of anyone isolating any of them from lubricating oil. If the oil had poor quality, the usual explanation is that the natural inhibitors have been removed or destroyed. It would appear that their existence offers a ready explanation for some things even though in many cases they are non-existent.

*Pupil:* Some work was done by the University of Pennsylvania sponsored by the American Petroleum Institute in making a study of hydrocarbons present in lubricating oil; it is the best information I have come across on this subject. You might theorize a little by studying hydrocarbons that are in the crude oil. About 15 to 25 percent by quantity was found to be paraffinic in a Mid-Continent crude oil.

*Pupil:* Just how many actual paraffinic side chains have they been able to obtain? I have been under the impression that $C_{27}$ was as high as the straight chain paraffins went, and that all heavier constituents were of the naphthene or aromatic types with the addition of paraffinic side chains. When I see these analyses giving 15 to 25 percent paraffins in a bright stock I am inclined to believe that a large part of this is obtained from the paraffinic side chain being broken off during the analysis and included therein.

*Leader:* Yes, that makes the analysis look entirely different, but I believe the analysis I referred to was between 15 and 25 percent.

*(To be continued in an early issue)*

☆ ☆ ☆

[1] "Modern Methods of Refining Lubricating Oils," by Vladimir A. Kalichevsky.

# THE *Petroleum* Engineer's CONTINUOUS TABLES

## A DAILY REFERENCE FOR OPERATING MEN

## INSTALLMENT NO. 60

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

**Nos. P000-P399—General**
**Nos. P400-P499—Drilling**
**Nos. P500-P599—Production**
**Nos. P600-P699—Transportation and Storage (includes Pipe Line)**
**Nos. P700-P799—Refining, including**
**Nos. P770-P799—Natural Gasoline, which may be classified in a separate division (as shown here) if of special interest to the user**

**To aid the reader in using the Decimal System, a subject index arranged alphabetically has been published, and is available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.**

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| Whitney Chain & Manufacturing Company | 178 | May | P 425.218.43 |

# CORRESPONDING DIFFERENTIALS—EQUAL FLOWS

## FOR 16-IN. FLANGES—Size of orifice plate to be installed, in.

| Size of Orifice plate in use, in. | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.06 | 0.03 | 0.01 | | | | | | | | | | | | | |
| 1½ | 0.32 | 0.13 | 0.06 | 0.03 | 0.02 | 0.01 | | | | | | | | | | |
| 2 | 1.0 | 0.41 | 0.20 | 0.11 | 0.06 | 0.04 | 0.03 | 0.02 | 0.01 | | | | | | | |
| 2½ | 2.4 | 1.0 | 0.48 | 0.26 | 0.15 | 0.10 | 0.06 | 0.04 | 0.03 | 0.02 | 0.02 | | | | | |
| 3 | 5.1 | 2.1 | 1.0 | 0.54 | 0.31 | 0.20 | 0.13 | 0.09 | 0.06 | 0.05 | 0.03 | 0.02 | | | | |
| 3½ | 9.4 | 3.8 | 1.8 | 1.0 | 0.59 | 0.37 | 0.24 | 0.16 | 0.12 | 0.08 | 0.06 | 0.05 | 0.03 | 0.03 | | |
| 4 | 16.0 | 6.6 | 3.2 | 1.8 | 1.0 | 0.62 | 0.41 | 0.23 | 0.20 | 0.14 | 0.11 | 0.08 | 0.06 | 0.05 | 0.03 | 0.03 |
| 4½ | 26.0 | 11.0 | 5.1 | 2.7 | 1.6 | 1.0 | 0.66 | 0.45 | 0.32 | 0.21 | 0.17 | 0.13 | 0.10 | 0.07 | 0.06 | 0.04 |
| 5 | 39.0 | 16.0 | 7.7 | 4.2 | 2.4 | 1.5 | 1.0 | 0.68 | 0.48 | 0.35 | 0.26 | 0.19 | 0.15 | 0.11 | 0.08 | 0.07 |
| 5½ | 47.0 | 23.0 | 11.0 | 6.1 | 3.6 | 2.2 | 1.5 | 1.0 | 0.71 | 0.51 | 0.38 | 0.28 | 0.21 | 0.16 | 0.12 | 0.10 |
| 6 | 81.0 | 33.0 | 16.0 | 8.6 | 5.1 | 3.2 | 2.1 | 1.4 | 1.0 | 0.73 | 0.54 | 0.40 | 0.30 | 0.23 | 0.18 | 0.13 |
| 6½ | | 46.0 | 22.0 | 12.0 | 7.0 | 4.4 | 2.9 | 2.0 | 1.4 | 1.0 | 0.74 | 0.55 | 0.42 | 0.32 | 0.24 | 0.19 |
| 7 | | 62.0 | 30.0 | 16.0 | 9.4 | 5.9 | 3.9 | 2.6 | 1.9 | 1.3 | 1.0 | 0.74 | 0.57 | 0.43 | 0.33 | 0.25 |
| 7½ | | 83.0 | 40.0 | 22.0 | 13.0 | 7.9 | 5.2 | 3.5 | 2.5 | 1.8 | 1.3 | 1.0 | 0.76 | 0.58 | 0.44 | 0.34 |
| 8 | | | 53.0 | 29.0 | 17.0 | 10.0 | 6.8 | 4.7 | 3.3 | 2.4 | 1.8 | 1.3 | 1.0 | 0.76 | 0.58 | 0.44 |
| 8½ | | | 70.0 | 38.0 | 22.0 | 14.0 | 9.0 | 6.2 | 4.4 | 3.2 | 2.3 | 1.7 | 1.3 | 1.0 | 0.76 | 0.59 |
| 9 | | | | 49.0 | 29.0 | 18.0 | 12.0 | 8.1 | 5.7 | 4.1 | 3.1 | 2.3 | 1.7 | 1.3 | 1.0 | 0.77 |
| 9½ | | | | 64.0 | 37.0 | 23.0 | 15.0 | 11.0 | 7.4 | 5.4 | 4.0 | 3.0 | 2.2 | 1.7 | 1.3 | 1.0 |

## FOR 18-IN. FLANGES—Size of orifice plate to be installed, in.

| Size of Orifice plate in use, in. | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 | 10½ | 11 | 11½ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1.0 | 0.41 | 0.20 | 0.11 | 0.06 | 0.04 | 0.03 | 0.02 | | | | | | | | | | | | |
| 2½ | 2.4 | 1.0 | 0.48 | 0.26 | 0.15 | 0.10 | 0.06 | 0.04 | 0.03 | 0.02 | | | | | | | | | | |
| 3 | 5.0 | 2.1 | 1.0 | 0.54 | 0.32 | 0.20 | 0.13 | 0.09 | 0.06 | 0.05 | 0.03 | 0.02 | | | | | | | | |
| 3½ | 9.4 | 3.8 | 1.9 | 1.0 | 0.59 | 0.37 | 0.24 | 0.16 | 0.12 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | | | | | |
| 4 | 16.0 | 6.5 | 3.2 | 1.7 | 1.0 | 0.62 | 0.41 | 0.28 | 0.20 | 0.14 | 0.11 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | | | |
| 4½ | 26.0 | 10.0 | 5.1 | 2.7 | 1.6 | 1.0 | 0.65 | 0.45 | 0.32 | 0.23 | 0.17 | 0.13 | 0.10 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | |
| 5 | 39.0 | 16.0 | 7.8 | 4.2 | 2.5 | 1.5 | 1.0 | 0.06 | 0.48 | 0.35 | 0.26 | 0.20 | 0.15 | 0.12 | 0.09 | 0.07 | 0.06 | 0.04 | 0.03 | 0.02 |
| 5½ | 57.0 | 23.0 | 11.0 | 6.1 | 3.6 | 2.2 | 1.5 | 1.0 | 0.70 | 0.51 | 0.38 | 0.29 | 0.22 | 0.17 | 0.13 | 0.10 | 0.08 | 0.06 | 0.05 | 0.04 |
| 6 | 81.0 | 33.0 | 16.0 | 8.6 | 5.1 | 3.2 | 2.1 | 1.4 | 1.0 | 0.73 | 0.54 | 0.41 | 0.31 | 0.24 | 0.19 | 0.15 | 0.11 | 0.09 | 0.07 | 0.05 |
| 6½ | | 46.0 | 22.0 | 12.0 | 7.0 | 4.4 | 2.8 | 2.0 | 1.4 | 1.0 | 0.74 | 0.56 | 0.43 | 0.33 | 0.26 | 0.20 | 0.16 | 0.12 | 0.10 | 0.08 |
| 7 | | 61.0 | 30.0 | 16.0 | 9.4 | 5.9 | 3.8 | 2.6 | 1.9 | 1.3 | 1.0 | 0.76 | 0.58 | 0.44 | 0.35 | 0.27 | 0.21 | 0.17 | 0.13 | 0.10 |
| 7½ | | 81.0 | 39.0 | 21.0 | 12.0 | 7.7 | 5.1 | 3.5 | 2.5 | 1.8 | 1.3 | 1.0 | 0.76 | 0.59 | 0.46 | 0.36 | 0.28 | 0.22 | 0.17 | 0.14 |
| 8 | | | 53.0 | 28.0 | 16.0 | 10.0 | 6.6 | 4.5 | 3.2 | 2.3 | 1.7 | 1.3 | 1.0 | 0.77 | 0.60 | 0.47 | 0.37 | 0.29 | 0.23 | 0.18 |
| 8½ | | | 67.0 | 36.0 | 21.0 | 13.0 | 8.6 | 5.9 | 4.2 | 3.0 | 2.2 | 1.7 | 1.3 | 1.0 | 0.78 | 0.61 | 0.48 | 0.37 | 0.30 | 0.23 |
| 9 | | | 86.0 | 46.0 | 27.0 | 17.0 | 11.0 | 7.6 | 5.4 | 3.9 | 2.9 | 2.2 | 1.7 | 1.3 | 1.0 | 0.78 | 0.61 | 0.48 | 0.38 | 0.30 |
| 9½ | | | | 59.0 | 35.0 | 22.0 | 14.0 | 9.7 | 6.9 | 5.0 | 3.7 | 2.8 | 2.1 | 1.7 | 1.3 | 1.0 | 0.78 | 0.62 | 0.49 | 0.39 |
| 10 | | | | 76.0 | 44.0 | 28.0 | 18.0 | 12.0 | 8.8 | 6.4 | 4.7 | 3.6 | 2.7 | 2.1 | 1.6 | 1.3 | 1.0 | 0.79 | 0.62 | 0.49 |
| 10½ | | | | 96.0 | 56.0 | 35.0 | 23.0 | 16.0 | 11.0 | 8.1 | 6.0 | 4.5 | 3.5 | 2.7 | 2.1 | 1.6 | 1.3 | 1.0 | 0.79 | 0.63 |
| 11 | | | | | 71.0 | 44.0 | 29.0 | 20.0 | 14.0 | 10.0 | 7.6 | 5.7 | 4.4 | 3.4 | 2.6 | 2.0 | 1.6 | 1.3 | 1.0 | 0.79 |
| 11½ | | | | | 90.0 | 56.0 | 37.0 | 25.0 | 18.0 | 13.0 | 9.6 | 7.2 | 5.5 | 4.3 | 3.3 | 2.6 | 2.0 | 1.6 | 1.3 | 1.0 |

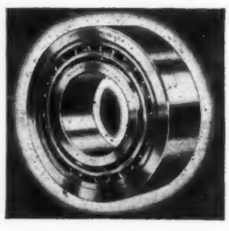
## FOR 20-IN. FLANGES—Size of orifice plate to be installed, in.

| Size of Orifice plate in use, in. | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 | 10½ | 11 | 11½ | 12 | 12½ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 1.0 | 0.54 | 0.32 | 0.20 | 0.13 | 0.09 | 0.06 | 0.05 | 0.03 | 0.02 | | | | | | | | | | |
| 3½ | 1.9 | 1.0 | 0.59 | 0.37 | 0.24 | 0.16 | 0.12 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | | | | | | | |
| 4 | 3.2 | 1.7 | 1.0 | 0.62 | 0.41 | 0.28 | 0.20 | 0.14 | 0.11 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | | | | | |
| 4½ | 5.1 | 2.7 | 1.6 | 1.0 | 0.66 | 0.45 | 0.32 | 0.23 | 0.17 | 0.13 | 0.10 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | | | |
| 5 | 7.7 | 4.2 | 2.4 | 1.5 | 1.0 | 0.68 | 0.48 | 0.35 | 0.26 | 0.20 | 0.15 | 0.12 | 0.09 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | |
| 5½ | 11.0 | 6.1 | 3.6 | 2.2 | 1.5 | 1.0 | 0.71 | 0.51 | 0.38 | 0.29 | 0.22 | 0.17 | 0.14 | 0.11 | 0.09 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 |
| 6 | 16.0 | 8.6 | 5.1 | 3.2 | 2.1 | 1.4 | 1.0 | 0.73 | 0.54 | 0.41 | 0.32 | 0.25 | 0.19 | 0.15 | 0.12 | 0.10 | 0.08 | 0.06 | 0.05 | 0.04 |
| 6½ | 22.0 | 12.0 | 7.0 | 4.4 | 2.9 | 2.0 | 1.4 | 1.0 | 0.74 | 0.56 | 0.44 | 0.34 | 0.27 | 0.21 | 0.17 | 0.14 | 0.11 | 0.09 | 0.07 | 0.06 |
| 7 | 30.0 | 16.0 | 9.4 | 5.9 | 3.8 | 2.6 | 1.9 | 1.3 | 1.0 | 0.76 | 0.59 | 0.46 | 0.36 | 0.29 | 0.23 | 0.18 | 0.15 | 0.12 | 0.10 | 0.08 |
| 7½ | 39.0 | 21.0 | 12.0 | 7.7 | 5.1 | 3.5 | 2.4 | 1.8 | 1.3 | 1.0 | 0.77 | 0.60 | 0.48 | 0.38 | 0.30 | 0.24 | 0.19 | 0.16 | 0.13 | 0.10 |
| 8 | 51.0 | 27.0 | 16.0 | 10.0 | 6.6 | 4.5 | 3.2 | 2.3 | 1.7 | 1.3 | 1.0 | 0.78 | 0.62 | 0.49 | 0.39 | 0.31 | 0.25 | 0.20 | 0.16 | 0.13 |
| 8½ | 65.0 | 35.0 | 20.0 | 13.0 | 8.4 | 5.7 | 4.0 | 2.9 | 2.2 | 1.7 | 1.3 | 1.0 | 0.79 | 0.62 | 0.50 | 0.40 | 0.32 | 0.26 | 0.21 | 0.17 |
| 9 | 82.0 | 44.0 | 26.0 | 16.0 | 11.0 | 7.3 | 5.1 | 3.7 | 2.8 | 2.1 | 1.6 | 1.3 | 1.0 | 0.79 | 0.63 | 0.51 | 0.41 | 0.33 | 0.27 | 0.22 |
| 9½ | | 56.0 | 33.0 | 20.0 | 13.0 | 9.2 | 6.5 | 4.7 | 3.5 | 2.7 | 2.1 | 1.6 | 1.3 | 1.0 | 0.80 | 0.64 | 0.51 | 0.42 | 0.34 | 0.27 |
| 10 | | 70.0 | 41.0 | 26.0 | 17.0 | 12.0 | 8.1 | 5.9 | 4.4 | 3.3 | 2.6 | 2.0 | 1.6 | 1.3 | 1.0 | 0.80 | 0.64 | 0.52 | 0.42 | 0.34 |
| 10½ | | 88.0 | 51.0 | 32.0 | 21.0 | 14.0 | 10.0 | 7.4 | 5.5 | 4.2 | 3.2 | 2.5 | 2.0 | 1.6 | 1.3 | 1.0 | 0.80 | 0.65 | 0.53 | 0.43 |
| 11 | | | 64.0 | 40.0 | 26.0 | 18.0 | 13.0 | 9.2 | 6.8 | 5.2 | 4.0 | 3.1 | 2.5 | 1.9 | 1.6 | 1.2 | 1.0 | 0.81 | 0.65 | 0.53 |
| 11½ | | | 79.0 | 49.0 | 32.0 | 22.0 | 16.0 | 11.0 | 8.4 | 6.4 | 4.9 | 3.9 | 3.0 | 2.4 | 1.9 | 1.5 | 1.2 | 1.0 | 0.81 | 0.66 |
| 12 | | | 98.0 | 61.0 | 40.0 | 27.0 | 19.0 | 14.0 | 10.0 | 7.9 | 6.1 | 4.8 | 3.8 | 3.0 | 2.4 | 1.9 | 1.5 | 1.2 | 1.0 | 0.81 |
| 12½ | | | | 75.0 | 49.0 | 34.0 | 24.0 | 17.0 | 13.0 | 9.7 | 7.5 | 5.6 | 4.6 | 3.7 | 2.9 | 2.3 | 1.9 | 1.5 | 1.2 | 1.0 |

Example: The highest differential reading on a 16 in. by 6 in. orifice plate is 98 in. It is desired to install a 16 in. by 7 in. orifice plate to lower the differential. What will be the differential with the 16 in. by 7 in. orifice plate installed?

In the 16 in. flange section of the table find the 6 in. orifice size. In the column headed 7 in. at the intersection find 0.54. Multiply 0.54 by 98 in. and the new differential reading will be 52.9 in. on the 16 in. by 7 in. plate.

**YES, IT'S ONE OF "OUR BOYS"** writing—but he's not being prejudiced. Hyatt's *do* play a major part in Army and Navy equipment ... in tanks and guns and planes and ships ... in the machines that make the machines of war. Everywhere, every day, precision-made Hyatt Bearings are serving well in America's drive toward victory.



Our young soldier's buddies in Department 9 at Hyatt are justly proud of him—and he can be equally proud of them. For they are soldiers, too ... in the front lines of industry ... working with might and main, day and night ... keeping a steady flow of vital parts for the fighting machines that our fighting men are using with such telling effect! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Pittsburgh, Detroit and San Francisco.

**THE 50TH YEAR OF HYATT ROLLER BEARINGS**

## EQUIVALENTS—GRAVITY, VOLUME, AND WEIGHT

| Specific Gravity | Degrees Baume | Degrees A..PI. | lb. per gal. | lb. per cu. ft. | lb. per bbl.* | gal. per ton† | *bbl. per ton† |
|---|---|---|---|---|---|---|---|
| 0.7587 | 54.523 | 55 | 6.326 | 47.319 | 265.7 | 316.2 | 7.53 |
| 0.7547 | 55.512 | 56 | 6.292 | 47.066 | 264.3 | 317.9 | 7.57 |
| 0.7507 | 56.502 | 57 | 6.258 | 46.816 | 262.9 | 319.6 | 7.61 |
| 0.7467 | 57.491 | 58 | 6.225 | 46.569 | 261.5 | 321.3 | 7.65 |
| 0.7428 | 58.481 | 59 | 6.193 | 46.325 | 260.1 | 323.0 | 7.69 |
| 0.7389 | 59.470 | 60 | 6.160 | 46.083 | 258.7 | 324.7 | 7.73 |
| 0.7351 | 60.459 | 61 | 6.128 | 45.844 | 257.4 | 326.3 | 7.77 |
| 0.7313 | 61.449 | 62 | 6.097 | 45.607 | 256.1 | 328.0 | 7.81 |
| 0.7275 | 62.438 | 63 | 6.065 | 45.372 | 254.7 | 329.7 | 7.85 |
| 0.7238 | 63.428 | 64 | 6.034 | 45.140 | 253.4 | 331.4 | 7.89 |
| 0.7201 | 64.417 | 65 | 6.004 | 44.910 | 252.2 | 333.1 | 7.93 |
| 0.7165 | 65.406 | 66 | 5.973 | 44.683 | 250.9 | 334.8 | 7.97 |
| 0.7128 | 66.396 | 67 | 5.943 | 44.458 | 249.6 | 336.5 | 8.01 |
| 0.7093 | 67.385 | 68 | 5.913 | 44.235 | 248.4 | 338.2 | 8.05 |
| 0.7057 | 68.375 | 69 | 5.884 | 44.008 | 247.1 | 339.9 | 8.09 |
| 0.7022 | 69.364 | 70 | 5.855 | 43.796 | 245.9 | 341.6 | 8.13 |
| 0.6988 | 70.353 | 71 | 5.826 | 43.580 | 244.7 | 343.3 | 8.17 |
| 0.6953 | 71.343 | 72 | 5.797 | 43.366 | 243.5 | 345.0 | 8.21 |
| 0.6919 | 72.332 | 73 | 5.769 | 43.154 | 242.3 | 346.7 | 8.25 |
| 0.6886 | 73.322 | 74 | 5.741 | 42.944 | 241.1 | 348.4 | 8.29 |
| 0.6852 | 74.311 | 75 | 5.713 | 42.736 | 239.9 | 350.1 | 8.34 |
| 0.6819 | 75.300 | 76 | 5.685 | 42.530 | 238.8 | 351.8 | 8.38 |
| 0.6787 | 76.290 | 77 | 5.658 | 42.326 | 237.6 | 353.5 | 8.42 |
| 0.6754 | 77.279 | 78 | 5.631 | 42.124 | 236.5 | 355.2 | 8.46 |
| 0.6722 | 78.269 | 79 | 5.604 | 41.924 | 235.4 | 356.9 | 8.50 |
| 0.6690 | 79.258 | 80 | 5.578 | 41.725 | 234.3 | 358.6 | 8.54 |
| 0.6659 | 80.247 | 81 | 5.552 | 41.529 | 233.2 | 360.3 | 8.58 |
| 0.6628 | 18.237 | 82 | 5.526 | 41.334 | 232.1 | 362.0 | 8.62 |
| 0.6597 | 82.226 | 83 | 5.500 | 41.142 | 231.0 | 363.6 | 8.66 |
| 0.6566 | 83.216 | 84 | 5.474 | 40.951 | 229.9 | 365.3 | 8.70 |
| 0.6536 | 84.205 | 85 | 5.449 | 40.762 | 228.9 | 367.0 | 8.74 |
| 0.6506 | 85.194 | 86 | 5.424 | 40.574 | 227.8 | 368.7 | 8.78 |
| 0.6476 | 86.184 | 87 | 5.399 | 40.389 | 226.8 | 370.4 | 8.82 |
| 0.6446 | 87.173 | 88 | 5.375 | 40.205 | 225.7 | 372.1 | 8.86 |
| 0.6417 | 88.163 | 89 | 5.350 | 40.022 | 224.7 | 373.8 | 8.90 |
| 0.6388 | 89.152 | 90 | 5.326 | 39.842 | 223.7 | 375.5 | 8.94 |
| 0.6360 | 90.141 | 91 | 5.302 | 39.662 | 222.7 | 377.2 | 8.98 |
| 0.6331 | 91.131 | 92 | 5.278 | 39.485 | 221.7 | 378.9 | 9.02 |
| 0.6303 | 92.120 | 93 | 5.255 | 39.309 | 220.7 | 380.6 | 9.06 |
| 0.6275 | 93.110 | 94 | 5.232 | 39.135 | 219.7 | 382.3 | 9.10 |
| 0.6247 | 94.099 | 95 | 5.208 | 38.962 | 218.8 | 384.0 | 9.14 |
| 0.6220 | 95.088 | 96 | 5.186 | 39.791 | 217.8 | 385.7 | 9.18 |
| 0.6193 | 96.078 | 97 | 5.163 | 38.621 | 216.8 | 387.4 | 9.22 |
| 0.6166 | 97.067 | 98 | 5.140 | 38.453 | 215.9 | 389.1 | 9.26 |
| 0.6139 | 98.057 | 99 | 5.118 | 38.286 | 215.0 | 390.8 | 9.31 |
| 0.6112 | 99.046 | 100 | 5.096 | 38.121 | 214.0 | 392.5 | 9.34 |

These equivalents are at 60°F. compared with water at 60°F.

*42 gal. per bbl.

†2000 lb. per ton.

**WIRE ROPE LASTS LONGER WITH PROPER CARE**

# 8 tips on lubricating WIRE ROPE

You'd have to look a long way to find a piece of equipment able to stand up under the terrific abuse which wire rope handles every day as a matter of course. Just because wire rope *can* take it, however, is no reason to subject the rope to abuses which could be avoided.

Take lubrication, for instance. You wouldn't think of running your car without plenty of oil in the crankcase. Wire rope, too, is a machine. In action, its many individual wires move relative to each other and twist around their own axes. To protect these "bearing" surfaces from rust and from wear, follow the simple rules outlined below. You'll be well repaid in longer service.

1. Clean wire rope carefully before lubricating it. Remove grit, dirt and other foreign matter with kerosene or gasoline and a stiff brush. Another method is to pull the rope through a tightly-wrapped swab.

2. If the rope has been working in a wet atmosphere, it may be coated with hydrated rust—a slimy film that cannot be removed until the rope is *thoroughly* dried out. To apply oil or grease on top of hydrated rust is simply wasted effort.

3. Choose a lubricant which is suited to the size and construction of rope, and to the working conditions. A stiff rope, with fewer, larger wires, requires a heavier lubricant, in general, than a more flexible rope with a greater number of wires.

4. When applying heavy lubricants to wire rope, thin them out by heating, so as to get the desired penetration. Use an ordinary metal vat or box with a gas flame under it. Pull the rope slowly through the hot lubricant. A sheave, partly submerged in the vat, will hold the rope down so that the lubricant can penetrate more readily.

5. If you are not using a heated vat, or a special drip-oiling device, the lubricant may be applied with an oil can or a paint brush, dipped in the lubricant.

6. Don't just apply any-oil-that's-handy to your wire rope. Some lubricants have an acid base and will actually eat into the wires, thus seriously damaging the rope. Be certain that the lubricant you apply to your rope is the correct one—that it won't "fight" with the lubricants already in the rope.

7. Ropes that operate at elevated temperatures require a lubricant that will hold its body at the working temperature. Use a fairly heavy lubricant, heat it above the working temperature of the rope, let it penetrate completely among the wires. It will cool and thicken at room temperature. But in service, the heat will thin out the lubricant to the right consistency.

8. Never let your wire rope rust or become dry of oil. Watch it carefully in service. Experience will show you how often to lubricate for best results. Every type of wire-rope job presents its own lubricating problem. If the load is heavy—if the rope works at high speed—bends frequently around sheaves—is exposed to moisture, grit or corrosive fumes—be particularly careful about lubrication. Remember, wire rope is a machine, and machines don't last long without proper lubrication.

**BETHLEHEM STEEL COMPANY**

BETHLEHEM STEEL

# LINE PIPE COEFFICIENTS FOR GAS FLOW—VALUES OF $d^{2.5}$

| Nominal size, in. | Wall Thickness, in. | Lb. per ft. plain ends | Inside diameter, d, in. | $d^{2.5}$ |
|---|---|---|---|---|
| **Steel pipe** | | | | |
| ID ⅛ Std. (A.P.I.) | 0.068 | 0.24 | 0.269 | 0.0375 |
| XH | 0.095 | 0.31 | 0.215 | 0.0214 |
| ¼ std. (A.P.I.) | 0.088 | 0.42 | 0.364 | 0.0799 |
| XH | 0.119 | 0.53 | 0.302 | 0.0501 |
| (Copper) ⅜ std. | 0.025 | 0.106 | 0.325 | 0.0602 |
| XH | 0.032 | 0.133 | 0.311 | 0.0539 |
| ⅜ std. (A.P.I.) | 0.091 | 0.57 | 0.493 | 0.1707 |
| XH | 0.126 | 0.73 | 0.423 | 0.1164 |
| (Copper) ½ std. | 0.025 | 0.144 | 0.450 | 0.1358 |
| XH | 0.049 | 0.269 | 0.402 | 0.1025 |
| ½ std. (A.P.I.) | 0.109 | 0.85 | 0.622 | 0.3051 |
| XH | 0.147 | 1.08 | 0.546 | 0.2203 |
| XXH | 0.294 | 1.71 | 0.252 | 0.0319 |
| (Copper) ⅝ std. | 0.028 | 0.203 | 0.569 | 0.2442 |
| XH | 0.049 | 0.344 | 0.527 | 0.2016 |
| ¾ std. (A.P.I.) | 0.113 | 1.13 | 0.824 | 0.6163 |
| XH | 0.154 | 1.47 | 0.742 | 0.4743 |
| XXH | 0.308 | 2.44 | 0.434 | 0.1241 |
| (Copper) ⅞ std. | 0.032 | 0.328 | 0.811 | 0.5923 |
| XH | 0.065 | 0.641 | 0.745 | 0.4791 |
| 1 std. (A.P.I.) | 0.133 | 1.68 | 1.049 | 1.1271 |
| XH | 0.179 | 2.17 | 0.957 | 0.8959 |
| XXH | 0.358 | 3.65 | 0.599 | 0.2777 |
| (Copper) 1⅛ std. | 0.035 | 0.464 | 1.055 | 1.1432 |
| XH | 0.065 | 0.839 | 0.995 | 0.9876 |
| 1¼ std. (A.P.I.) | 0.140 | 2.27 | 1.380 | 2.2372 |
| XH | 0.191 | 2.99 | 1.278 | 1.8464 |
| XXH | 0.382 | 5.21 | 0.896 | 0.7599 |
| (Copper) 1⅜ std. | 0.042 | 0.681 | 1.291 | 1.8937 |
| XH | 0.065 | 1.040 | 1.245 | 1.7295 |
| 1½ std. (A.P.I.) | 0.145 | 2.72 | 1.610 | 3.2890 |
| XH | 0.200 | 3.63 | 1.500 | 2.7557 |
| XXH | 0.400 | 6.40 | 1.100 | 1.2691 |
| (Copper) 1⅝ std. | 0.049 | 0.940 | 1.527 | 2.8814 |
| XH | 0.072 | 1.360 | 1.481 | 2.6692 |
| (Brass) OD 2 in. tubes | 0.095 | 1.932 | 1.810 | 4.4075 |
| | 0.109 | 2.201 | 1.782 | 4.2390 |
| | 0.120 | 2.409 | 1.760 | 4.1094 |
| | 0.134 | 2.670 | 1.732 | 3.9489 |
| (Brass) 2¼ tubes | 0.095 | 2.186 | 2.060 | 6.0907 |
| | 0.109 | 2.492 | 2.032 | 5.8859 |
| | 0.120 | 2.729 | 2.010 | 5.7278 |
| | 0.134 | 3.028 | 1.982 | 5.5304 |
| 2⅛ std. 2 in. (A.P.I.) | 0.154 | 3.65 | 2.067 | 6.1426 |
| XH | 0.218 | 5.02 | 1.939 | 5.2293 |
| XXH | 0.436 | 9.02 | 1.503 | 2.7695 |
| (Brass) 2½ tubes | 0.109 | 2.783 | 2.282 | 7.8666 |
| | 0.120 | 3.050 | 2.260 | 7.6784 |
| | 0.134 | 3.386 | 2.232 | 7.4428 |
| (Brass) 2¾ tubes | 0.109 | 3.074 | 2.532 | 10.2014 |
| | 0.120 | | 2.510 | 9.9812 |
| | 0.134 | | 2.482 | 9.7052 |
| 2⅞ std. 2½ in. (A.P.I.) | 0.203 | 5.79 | 2.469 | 9.5786 |
| XH | 0.276 | 7.66 | 2.323 | 8.2248 |
| XXH | 0.552 | 13.69 | 1.771 | 4.1740 |
| 3 | 0.109 | 3.365 | 2.782 | 12.9090 |
| | 0.120 | 3.691 | 2.760 | 12.6553 |
| | 0.125 | | 2.750 | 12.5410 |
| | 0.134 | 4.101 | 2.732 | 12.3368 |
| | 0.148 | 4.508 | 2.704 | 12.0231 |
| | 0.1875 | | 2.725 | 12.2579 |
| | 0.216 | | 2.568 | 10.5679 |
| | 0.241 | | 2.518 | 10.0610 |
| | 0.254 | | 2.492 | 9.8033 |
| | 0.289 | | 2.422 | 9.1292 |
| 3½ | 0.120 | 4.331 | 3.260 | 19.1786 |
| | 0.125 | 4.50 | 3.250 | 19.0418 |
| | 0.148 | 5.29 | 3.204 | 18.3752 |
| | 0.1875 | 6.63 | 3.125 | 17.2634 |
| std. 3 in. (A.P.I.) | 0.216 | 7.58 | 3.068 | 16.4869 |
| | 0.241 | 8.38 | 3.018 | 15.8233 |
| | 0.254 | 8.80 | 2.992 | 15.4847 |
| | 0.289 | 9.91 | 2.922 | 14.5949 |
| XH | 0.300 | 10.25 | 2.900 | 14.3217 |
| XXH | 0.600 | 18.58 | 2.300 | 8.0227 |
| **Steel pipe** | | | | |
| 4 | 0.128 | 5.29 | 3.744 | 27.1231 |
| | 0.134 | 5.53 | 3.732 | 26.9063 |
| | 0.148 | 6.08 | 3.704 | 26.4045 |
| | 0.1875 | 7.63 | 3.625 | 25.0190 |
| std. 3½ in. (A.P.I.) | 0.226 | 9.11 | 3.548 | 23.7115 |
| XH | 0.318 | 12.50 | 3.364 | 20.7558 |
| 4½ | 0.128 | 5.97 | 4.372 | 39.9669 |
| | 0.134 | 6.24 | 4.232 | 36.8438 |
| | 0.142 | 6.60 | 4.216 | 36.4965 |
| | 0.148 | 6.87 | 4.204 | 36.2374 |
| | 0.165 | 7.63 | 4.170 | 35.5092 |
| | 0.180 | 8.30 | 4.140 | 34.8739 |
| | 0.1875 | 8.63 | 4.125 | 34.5589 |
| | 0.203 | 9.31 | 4.094 | 33.9133 |
| | 0.205 | 9.40 | 4.090 | 33.8305 |
| std. 4 in. (A.P.I.) | 0.237 | 10.79 | 4.026 | 32.5225 |
| | 0.250 | 11.34 | 4.000 | 32.0000 |
| | 0.252 | 11.43 | 3.996 | 31.9200 |
| | 0.255 | 11.56 | 3.990 | 31.8004 |
| | 0.271 | 12.24 | 3.958 | 31.1666 |
| | 0.3125 | 13.97 | 3.875 | 29.5583 |
| XH | 0.337 | 14.98 | 3.826 | 28.6323 |
| XXH | 0.674 | 27.54 | 3.152 | 17.6387 |
| 4¾ | 0.134 | 6.60 | 4.482 | 42.5285 |
| | 0.145 | 7.13 | 4.460 | 42.0085 |
| | 0.165 | 8.07 | 4.420 | 41.0729 |
| | 0.1875 | 9.13 | 4.375 | 40.0355 |
| | 0.193 | 9.39 | 4.364 | 39.7843 |
| | 0.250 | 12.01 | 4.250 | 37.2368 |
| | 0.3125 | 14.81 | 4.125 | 34.5589 |
| | 0.334 | 15.75 | 4.082 | 33.6653 |
| 5 | 0.134 | 6.96 | 4.732 | 48.7093 |
| | 0.148 | 7.66 | 4.704 | 47.9920 |
| | 0.152 | 7.87 | 4.696 | 47.7882 |
| | 0.165 | 8.52 | 4.670 | 47.1295 |
| | 0.180 | 9.26 | 4.640 | 46.3762 |
| | 0.1875 | 9.63 | 4.625 | 46.0023 |
| | 0.203 | 10.40 | 4.594 | 45.2353 |
| | 0.220 | 11.23 | 4.560 | 44.4030 |
| | 0.247 | 12.53 | 4.506 | 43.1001 |
| | 0.250 | 12.68 | 4.500 | 42.9567 |
| | 0.253 | 12.82 | 4.494 | 42.8137 |
| | 0.288 | 14.49 | 4.424 | 41.1659 |
| | 0.296 | 14.87 | 4.408 | 40.7947 |
| | 0.306 | 15.34 | 4.388 | 40.3336 |
| | 0.3125 | 15.64 | 4.375 | 40.0355 |
| | 0.355 | 17.61 | 4.290 | 38.1192 |
| 5¼ | 0.134 | 7.32 | 4.982 | 55.3999 |
| | 0.153 | 8.32 | 4.944 | 54.3496 |
| | 0.182 | 9.85 | 4.886 | 52.7696 |
| | 0.1875 | 10.13 | 4.875 | 52.4731 |
| | 0.241 | 12.89 | 4.768 | 49.6410 |
| | 0.250 | 13.35 | 4.750 | 49.1738 |
| | 0.301 | 15.90 | 4.648 | 46.5763 |
| | 0.3125 | 16.47 | 4.625 | 46.0023 |
| 5½ | 0.134 | 7.67 | 5.232 | 62.6137 |
| | 0.154 | 8.79 | 5.192 | 61.4238 |
| | 0.165 | 9.40 | 5.170 | 60.7752 |
| | 0.1875 | 10.63 | 5.125 | 59.4614 |
| | 0.228 | 12.83 | 5.044 | 57.1397 |
| | 0.250 | 14.01 | 5.000 | 55.9017 |
| | 0.304 | 16.87 | 4.892 | 52.9317 |
| | 0.3125 | 17.31 | 4.875 | 52.4731 |
| | 0.361 | 19.81 | 4.778 | 49.9017 |
| 5⅝ | 0.148 | 8.55 | 5.2665 | 63.6510 |
| | 0.15625 | 9.02 | 5.2500 | 63.1536 |
| | 0.165 | 9.51 | 5.2325 | 62.6286 |
| | 0.1875 | 10.76 | 5.1875 | 61.2908 |
| | 0.250 | 14.18 | 5.0625 | 57.6650 |
| std. 5 in. (A.P.I.) | 0.258 | 14.62 | 5.0465 | 57.2105 |
| | 0.293 | 16.49 | 4.9765 | 55.2472 |
| | 0.304 | 17.07 | 4.9545 | 54.6386 |
| | 0.3125 | 17.52 | 4.9375 | 54.1711 |
| | 0.375 | 20.77 | 4.8125 | 50.8074 |
| 6 | 0.140 | 8.76 | 5.720 | 78.2510 |
| | 0.148 | 9.25 | 5.704 | 77.7050 |
| | 0.15625 | 9.75 | 5.6865 | 77.1103 |
| | 0.164 | 10.22 | 5.672 | 76.6197 |
| | 0.165 | 10.28 | 5.670 | 76.5524 |
| | 0.180 | 11.18 | 5.640 | 75.5436 |
| | 0.187 | 11.63 | 5.626 | 75.0757 |
| | 0.190 | 11.78 | 5.620 | 74.8757 |
| | 0.203 | 12.56 | 5.594 | 74.0127 |
| | 0.21875 | 13.50 | 5.5625 | 72.9752 |
| | 0.220 | 13.58 | 5.560 | 72.8932 |
| | 0.224 | 13.81 | 5.552 | 72.6313 |
| | 0.238 | 14.64 | 5.524 | 71.7190 |
| | 0.250 | 15.35 | 5.500 | 70.9426 |
| | 0.259 | 15.88 | 5.482 | 70.3635 |
| | 0.275 | 16.81 | 5.450 | 69.3412 |
| | 0.324 | 19.64 | 5.352 | 66.2660 |
| | 0.359 | 21.62 | 5.282 | 64.1204 |

This group of tables was prepared by P. McDonald Biddison in connection with the article, "Computing Gas Flow in Pipe Lines," published in the August, September, and October, 1941, issues of *The Petroleum Engineer*.

As the general equation for the flow of gas in long lines involves a knowledge of the exact value of the internal diameter of the pipe, d, raised to the 2.5 power, these tables should facilitate flow calculations.

See sheet 5, column 2, of this series (P 622.001.) for similar data on cast iron pipe.

# Yes..We've used NO-OX-ID for years. Some of our pipe lines were laid 25 years ago

Applying NO-OX-IDized Wrappers by hand to transmission line.

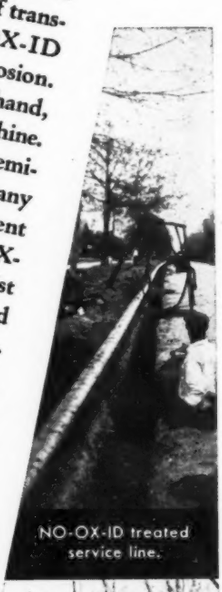
Whether your problem is to protect a few feet of service line or miles of transmission line, there is a NO-OX-ID formula to stop loss due to corrosion. It can be applied hot or cold, by hand, traveling machine, or stationary machine.

NO-OX-ID coatings contain chemical inhibitors which render passive any pits or corrosion that may be present when the coating is applied. NO-OX-IDized wrappers are reinforced to resist soil action and thoroughly impregnated with NO-OX-ID to repel moisture.

**COMBINATION OF NO-OX-ID COATINGS AND NO-OX-IDIZED WRAPPERS FURNISHES *Complete Protection***

DEARBORN CHEMICAL COMPANY
Dept. L, 310 S. Michigan Ave., Chicago

NO-OX-ID IRON RUST
TRADE MARK
The Original Rust Preventive



NO-OX-ID treated service line.

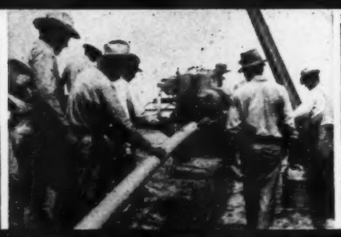
Applying NO-OX-ID by hand.

NO-OX-IDized Wrapper applied over NO-OX-ID in pipe yard.

12" Gas line coated with NO-OX-ID for river crossing.

Applying NO-OX-IDized Wrapper to pipe line.

Field service men and machine with coating and wrapping gang.



Wrapper being applied by traveling machine.

Testing coating at high voltage for pin holes or voids before placing in ground.

**Static Press.**
**1600-1695 lb.**

# PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

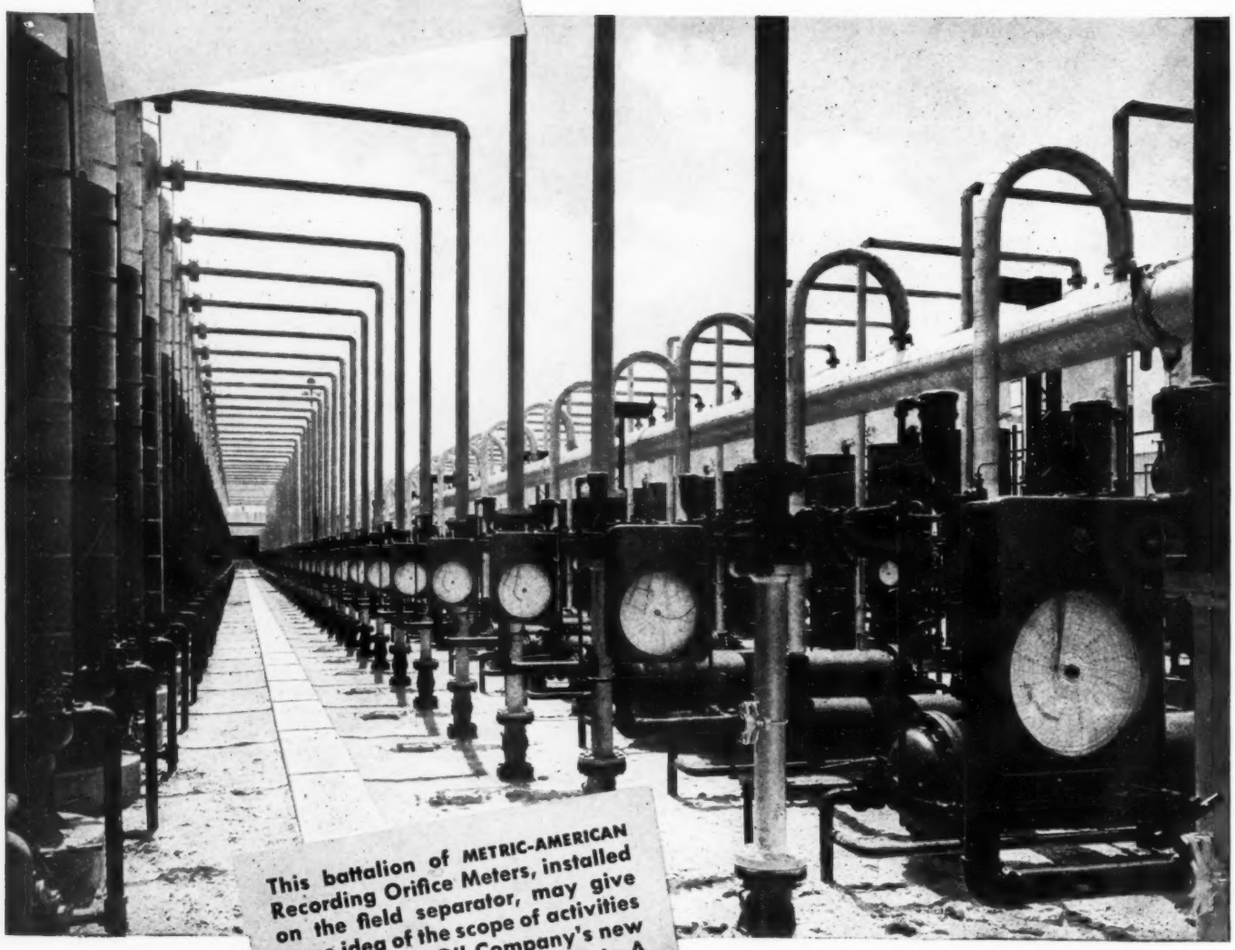
| Differential pressure, in. of water | Static pressure, lb. per sq. in., ga. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1600 | 1605 | 1610 | 1615 | 1620 | 1625 | 1630 | 1635 | 1640 | 1645 | 1650 | 1655 | 1660 | 1665 | 1670 | 1675 | 1680 | 1685 | 1690 | 1695 |
| 2 | 56.83 | 56.91 | 56.99 | 57.08 | 57.17 | 57.25 | 57.35 | 57.44 | 57.52 | 57.61 | 57.69 | 57.78 | 57.88 | 57.96 | 58.04 | 58.13 | 58.21 | 58.30 | 58.38 | 58.47 |
| 4 | 80.38 | 80.50 | 80.62 | 80.74 | 80.86 | 80.98 | 81.12 | 81.24 | 81.36 | 81.48 | 81.60 | 81.72 | 81.86 | 81.98 | 82.10 | 82.22 | 82.34 | 82.46 | 82.58 | 82.70 |
| 6 | 98.43 | 98.57 | 98.72 | 98.87 | 99.01 | 99.16 | 99.33 | 99.48 | 99.63 | 99.77 | 99.92 | 101.1 | 100.2 | 100.4 | 100.5 | 100.7 | 100.8 | 100.9 | 101.1 | 101.3 |
| 8 | 113.7 | 113.8 | 114.0 | 114.2 | 114.3 | 114.5 | 114.7 | 114.9 | 115.0 | 115.2 | 115.4 | 115.6 | 115.8 | 115.9 | 116.1 | 116.3 | 116.4 | 116.6 | 116.8 | 116.9 |
| 10 | 127.1 | 127.3 | 127.5 | 127.6 | 127.8 | 128.0 | 128.3 | 124.8 | 128.6 | 128.8 | 129.0 | 129.2 | 129.4 | 129.6 | 129.8 | 129.9 | 130.2 | 130.4 | 130.6 | 130.7 |
| 12 | 139.2 | 139.4 | 139.6 | 139.8 | 140.0 | 140.3 | 140.5 | 140.7 | 140.9 | 141.1 | 141.3 | 141.5 | 141.8 | 141.9 | 142.2 | 142.4 | 142.6 | 142.8 | 143.0 | 143.2 |
| 14 | 150.4 | 150.6 | 150.8 | 151.1 | 151.3 | 151.5 | 151.8 | 152.0 | 152.2 | 152.5 | 152.7 | 152.9 | 153.2 | 153.4 | 153.6 | 153.8 | 154.1 | 154.3 | 154.5 | 154.7 |
| 16 | 160.8 | 161.0 | 161.2 | 161.5 | 161.7 | 162.0 | 162.2 | 162.5 | 162.7 | 163.0 | 163.2 | 163.4 | 163.7 | 164.0 | 164.2 | 164.4 | 164.7 | 164.9 | 165.2 | 165.4 |
| 18 | 170.5 | 170.8 | 171.0 | 171.3 | 171.5 | 171.8 | 172.1 | 172.4 | 172.6 | 172.9 | 173.1 | 173.4 | 173.7 | 173.9 | 174.2 | 174.4 | 174.7 | 174.9 | 175.2 | 175.4 |
| 20 | 179.7 | 179.9 | 180.3 | 180.5 | 180.8 | 181.1 | 181.4 | 181.7 | 181.9 | 182.2 | 182.5 | 182.7 | 183.0 | 183.3 | 183.6 | 183.8 | 184.1 | 184.4 | 184.6 | 184.9 |
| 21 | 184.2 | 184.5 | 184.7 | 184.0 | 185.3 | 185.6 | 185.9 | 186.2 | 186.4 | 186.7 | 186.9 | 187.3 | 187.6 | 187.9 | 188.1 | 188.4 | 188.7 | 188.9 | 189.2 | 189.5 |
| 22 | 188.5 | 188.8 | 189.1 | 189.3 | 189.6 | 189.9 | 190.2 | 190.5 | 190.8 | 191.1 | 191.4 | 191.6 | 191.9 | 192.2 | 192.5 | 192.8 | 193.1 | 193.4 | 193.7 | 193.9 |
| 23 | 192.8 | 193.0 | 193.3 | 193.6 | 193.9 | 194.2 | 194.5 | 194.8 | 195.1 | 195.4 | 195.7 | 196.0 | 196.3 | 196.6 | 196.9 | 197.2 | 197.4 | 197.7 | 198.0 | 198.3 |
| 24 | 196.9 | 197.2 | 197.5 | 197.8 | 198.1 | 198.4 | 198.7 | 198.9 | 199.3 | 199.6 | 199.9 | 200.2 | 200.5 | 200.8 | 201.1 | 201.4 | 201.7 | 201.9 | 202.3 | 202.6 |
| 25 | 200.9 | 201.3 | 201.6 | 201.9 | 202.2 | 202.4 | 202.8 | 203.1 | 203.4 | 203.7 | 204.0 | 204.3 | 204.7 | 204.9 | 205.3 | 205.6 | 205.9 | 206.2 | 206.5 | 206.8 |
| 26 | 204.9 | 205.2 | 205.5 | 205.8 | 206.2 | 206.5 | 206.8 | 207.1 | 207.4 | 207.7 | 208.0 | 208.3 | 208.7 | 209.0 | 209.3 | 209.6 | 209.9 | 210.2 | 210.5 | 210.8 |
| 27 | 208.8 | 209.1 | 209.4 | 209.8 | 210.1 | 210.4 | 210.7 | 211.1 | 211.4 | 211.7 | 211.9 | 212.3 | 212.7 | 212.9 | 213.3 | 213.6 | 213.9 | 214.2 | 214.5 | 214.9 |
| 28 | 212.7 | 213.0 | 213.3 | 213.6 | 213.9 | 214.3 | 214.6 | 214.9 | 215.3 | 215.6 | 215.9 | 216.2 | 216.6 | 216.9 | 217.2 | 217.5 | 217.9 | 218.2 | 218.5 | 218.8 |
| 29 | 216.4 | 216.7 | 217.1 | 217.4 | 217.7 | 218.0 | 218.4 | 218.7 | 219.1 | 219.4 | 219.7 | 220.0 | 220.4 | 220.7 | 221.1 | 221.4 | 221.7 | 222.0 | 222.3 | 222.7 |
| 30 | 220.1 | 220.4 | 220.8 | 221.1 | 221.4 | 221.8 | 222.1 | 222.5 | 222.8 | 223.1 | 223.5 | 223.8 | 224.2 | 224.5 | 224.8 | 225.2 | 225.5 | 225.8 | 226.1 | 226.5 |
| 31 | 223.8 | 224.1 | 224.4 | 224.8 | 225.1 | 225.4 | 225.8 | 226.2 | 226.5 | 226.8 | 227.2 | 227.5 | 227.9 | 228.2 | 228.6 | 228.9 | 229.2 | 229.6 | 229.9 | 230.2 |
| 32 | 227.4 | 227.7 | 228.0 | 228.4 | 228.7 | 229.1 | 229.4 | 229.8 | 230.1 | 230.5 | 230.8 | 231.1 | 231.5 | 231.9 | 232.2 | 232.6 | 232.9 | 233.2 | 233.6 | 233.9 |
| 33 | 230.9 | 231.2 | 231.6 | 231.9 | 232.3 | 232.6 | 233.0 | 233.4 | 233.7 | 234.0 | 234.4 | 234.7 | 235.1 | 235.5 | 235.8 | 236.2 | 236.5 | 236.9 | 237.2 | 237.6 |
| 34 | 234.3 | 234.7 | 235.0 | 235.4 | 235.7 | 236.1 | 236.5 | 236.9 | 237.2 | 237.6 | 237.9 | 238.3 | 238.7 | 239.0 | 239.4 | 239.7 | 240.1 | 240.4 | 240.8 | 241.1 |
| 35 | 237.8 | 238.1 | 238.5 | 238.8 | 239.2 | 239.5 | 239.9 | 240.3 | 240.7 | 241.0 | 241.4 | 241.7 | 242.1 | 242.5 | 242.8 | 243.2 | 243.6 | 243.9 | 244.3 | 244.6 |
| 36 | 241.1 | 241.5 | 241.9 | 242.2 | 242.6 | 242.9 | 243.4 | 243.7 | 244.1 | 244.4 | 244.8 | 245.2 | 245.6 | 245.9 | 246.3 | 246.7 | 247.0 | 247.4 | 247.7 | 248.1 |
| 37 | 244.5 | 244.8 | 245.2 | 245.6 | 245.9 | 246.3 | 246.7 | 247.1 | 247.5 | 247.8 | 248.2 | 248.6 | 248.9 | 249.3 | 249.7 | 250.1 | 250.4 | 250.8 | 251.2 | 251.5 |
| 38 | 247.7 | 248.1 | 248.5 | 248.8 | 249.2 | 249.6 | 250.0 | 250.4 | 250.8 | 251.1 | 251.5 | 251.9 | 252.2 | 252.7 | 253.0 | 253.4 | 253.7 | 254.1 | 254.5 | 254.9 |
| 39 | 250.9 | 251.4 | 251.7 | 252.1 | 252.5 | 252.8 | 253.3 | 253.7 | 254.0 | 254.4 | 254.8 | 255.2 | 255.6 | 255.9 | 256.4 | 256.1 | 257.1 | 257.5 | 257.8 | 258.2 |
| 40 | 254.2 | 254.6 | 254.9 | 255.3 | 255.7 | 256.1 | 256.5 | 256.9 | 257.3 | 257.7 | 258.1 | 258.4 | 258.8 | 259.3 | 259.6 | 260.0 | 260.4 | 260.8 | 261.2 | 261.5 |
| 41 | 257.3 | 257.7 | 258.1 | 258.5 | 258.8 | 259.2 | 259.7 | 260.1 | 260.5 | 260.8 | 261.2 | 261.6 | 262.1 | 262.4 | 262.8 | 263.2 | 263.6 | 263.9 | 264.4 | 264.7 |
| 42 | 260.5 | 260.8 | 261.2 | 262.6 | 262.0 | 262.4 | 262.8 | 263.3 | 263.6 | 264.0 | 264.4 | 264.8 | 265.3 | 265.6 | 266.0 | 266.4 | 266.8 | 267.2 | 267.6 | 267.9 |
| 43 | 263.5 | 263.5 | 264.3 | 264.7 | 265.0 | 265.5 | 265.9 | 266.3 | 266.7 | 267.1 | 267.5 | 267.9 | 268.4 | 268.8 | 269.2 | 269.6 | 269.9 | 270.3 | 270.7 | 271.1 |
| 44 | 266.6 | 266.9 | 267.4 | 267.7 | 268.2 | 268.6 | 279.0 | 269.4 | 269.8 | 270.2 | 270.6 | 271.0 | 271.5 | 271.8 | 272.3 | 272.7 | 273.1 | 273.5 | 273.9 | 274.3 |
| 45 | 269.6 | 269.9 | 270.4 | 270.8 | 271.2 | 271.6 | 272.1 | 262.5 | 272.8 | 273.3 | 273.7 | 274.1 | 274.5 | 274.9 | 275.4 | 275.7 | 276.2 | 276.6 | 276.9 | 277.4 |
| 46 | 272.6 | 272.9 | 273.4 | 273.8 | 274.2 | 274.6 | 275.1 | 275.5 | 275.9 | 276.3 | 276.7 | 277.1 | 277.6 | 277.9 | 278.5 | 278.8 | 279.2 | 279.6 | 280.0 | 280.4 |
| 47 | 275.5 | 275.9 | 276.4 | 276.8 | 277.2 | 277.6 | 278.1 | 278.5 | 278.9 | 279.3 | 279.7 | 280.1 | 280.6 | 281.0 | 281.4 | 281.8 | 282.3 | 282.7 | 283.1 | 283.5 |
| 48 | 278.4 | 278.8 | 279.3 | 279.7 | 280.1 | 280.5 | 280.9 | 281.4 | 281.8 | 282.2 | 282.7 | 283.1 | 283.6 | 283.9 | 284.4 | 284.8 | 285.2 | 285.6 | 286.1 | 286.5 |
| 49 | 281.3 | 281.8 | 282.2 | 282.6 | 283.0 | 283.4 | 283.9 | 284.3 | 284.8 | 285.2 | 285.6 | 286.0 | 286.5 | 286.9 | 287.4 | 287.8 | 288.2 | 288.6 | 289.0 | 289.5 |
| 50 | 284.2 | 284.6 | 285.0 | 285.4 | 285.8 | 286.3 | 286.8 | 287.2 | 287.6 | 288.1 | 288.5 | 288.9 | 289.4 | 289.8 | 290.3 | 290.7 | 291.1 | 291.5 | 291.9 | 292.4 |
| 51 | 286.9 | 287.4 | 287.8 | 288.3 | 288.7 | 289.1 | 289.6 | 290.1 | 290.5 | 290.9 | 291.4 | 291.8 | 292.3 | 292.7 | 293.1 | 293.6 | 293.9 | 294.4 | 294.8 | 295.3 |
| 52 | 289.8 | 290.2 | 290.7 | 291.1 | 291.5 | 291.9 | 292.5 | 292.9 | 293.3 | 293.7 | 294.2 | 294.6 | 295.1 | 295.6 | 296.0 | 296.4 | 296.8 | 297.3 | 297.7 | 298.2 |
| 53 | 292.6 | 293.0 | 293.5 | 293.9 | 294.3 | 294.7 | 295.3 | 295.7 | 296.2 | 296.6 | 297.0 | 297.5 | 297.9 | 298.4 | 298.8 | 299.3 | 299.7 | 300.2 | 300.6 | 301.0 |
| 54 | 295.3 | 295.7 | 296.2 | 296.6 | 297.1 | 297.5 | 298.0 | 298.5 | 298.9 | 299.4 | 299.8 | 300.2 | 300.7 | 301.2 | 301.6 | 302.1 | 302.5 | 302.9 | 303.4 | 303.8 |
| 55 | 298.0 | 298.5 | 298.9 | 299.4 | 299.8 | 300.3 | 300.8 | 301.2 | 301.7 | 302.1 | 302.6 | 303.0 | 303.5 | 303.9 | 304.4 | 304.9 | 305.3 | 305.7 | 306.2 | 306.6 |
| 56 | 300.7 | 301.2 | 301.6 | 302.1 | 302.5 | 302.9 | 303.5 | 303.9 | 304.4 | 304.8 | 305.3 | 305.7 | 306.3 | 306.7 | 30.7. | 307.6 | 308.1 | 308.5 | 308.9 | 309.4 |
| 57 | 303.4 | 303.8 | 304.3 | 304.8 | 305.2 | 305.7 | 306.2 | 306.7 | 307.1 | 307.6 | 308.0 | 308.5 | 309.0 | 309.5 | 309.9 | 310.4 | 310.8 | 311.3 | 311.7 | 312.2 |
| 58 | 306.1 | 306.5 | 307.0 | 307.4 | 307.9 | 308.4 | 308.9 | 309.4 | 309.8 | 310.3 | 310.7 | 311.2 | 311.7 | 312.2 | 312.6 | 313.1 | 313.5 | 314.0 | 314.5 | 314.9 |
| 59 | 308.7 | 309.2 | 309.6 | 310.1 | 310.5 | 311.0 | 311.5 | 312.0 | 312.5 | 312.9 | 313.4 | 313.8 | 314.4 | 314.8 | 315.3 | 315.7 | 316.2 | 316.7 | 317.1 | 317.6 |
| 60 | 311.3 | 311.7 | 312.2 | 312.7 | 313.2 | 313.6 | 314.2 | 314.6 | 315.1 | 315.6 | 316.0 | 316.5 | 317.0 | 317.5 | 317.9 | 318.4 | 318.9 | 319.4 | 319.8 | 320.3 |
| 61 | 313.8 | 314.4 | 314.8 | 315.3 | 315.7 | 316.2 | 316.7 | 317.2 | 317.7 | 318.2 | 318.6 | 319.1 | 319.6 | 320.1 | 320.6 | 321.1 | 321.5 | 322.0 | 322.5 | 322.9 |
| 62 | 316.5 | 316.9 | 317.4 | 317.8 | 318.3 | 318.8 | 319.4 | 319.8 | 320.3 | 320.8 | 321.3 | 321.7 | 322.3 | 322.8 | 323.2 | 323.7 | 324.2 | 324.6 | 325.1 | 325.6 |
| 63 | 318.9 | 319.5 | 319.9 | 320.4 | 320.9 | 321.4 | 321.9 | 322.4 | 322.8 | 323.4 | 323.8 | 324.3 | 324.8 | 325.3 | 325.8 | 326.3 | 326.7 | 327.2 | 327.7 | 328.2 |
| 64 | 321.5 | 322.0 | 322.5 | 322.9 | 323.4 | 323.9 | 324.5 | 324.9 | 325.4 | 325.9 | 326.4 | 326.8 | 327.4 | 327.9 | 328.4 | 328.8 | 329.4 | 329.8 | 330.3 | 330.8 |
| 65 | 324.0 | 324.5 | 324.9 | 325.5 | 325.9 | 326.4 | 326.9 | 327.5 | 327.9 | 328.4 | 328.9 | 329.4 | 329.9 | 330.5 | 330.9 | 331.4 | 331.9 | 332.4 | 332.8 | 333.4 |
| 66 | 326.5 | 326.9 | 327.5 | 327.9 | 328.4 | 328.9 | 329.5 | 329.9 | 330.5 | 330.9 | 331.4 | 331.9 | 332.5 | 333.0 | 333.5 | 333.9 | 334.4 | 334.9 | 335.4 | 335.9 |
| 67 | 328.9 | 329.4 | 329.9 | 330.4 | 330.9 | 331.4 | 331.9 | 332.5 | 332.9 | 333.4 | 333.9 | 334.4 | 335.0 | 335.5 | 335.9 | 336.5 | 336.9 | 337.5 | 337.9 | 338.4 |
| 68 | 331.4 | 331.9 | 332.4 | 332.9 | 333.4 | 333.8 | 334.4 | 334.9 | 335.4 | 335.9 | 336.4 | 336.9 | 337.5 | 338.0 | 338.5 | 338.9 | 339.5 | 339.9 | 340.5 | 340.9 |
| 69 | 333.8 | 334.3 | 334.8 | 335.3 | 335.8 | 336.3 | 336.9 | 337.4 | 337.9 | 338.4 | 338.9 | 339.4 | 340.0 | 340.5 | 341.0 | 341.5 | 341.9 | 342.5 | 342.9 | 343.5 |
| 70 | 336.3 | 336.7 | 337.3 | 337.7 | 338.3 | 338.7 | 339.4 | 339.8 | 340.4 | 340.8 | 341.4 | 341.8 | 342.5 | 342.9 | 343.5 | 343.9 | 344.5 | 344.9 | 345.5 | 345.9 |
| 71 | 338.6 | 339.1 | 339.6 | 340.1 | 340.7 | 341.2 | 341.7 | 342.3 | 342.7 | 343.3 | 343.8 | 344.3 | 344.8 | 345.4 | 345.8 | 346.4 | 346.9 | 347.4 | 347.9 | 348.4 |
| 72 | 341.0 | 341.5 | 342.0 | 342.5 | 343.0 | 343.6 | 344.2 | 344.7 | 345.2 | 345.7 | 346.2 | 346.7 | 347.3 | 347.8 | 347.3 | 348.8 | 349.3 | 349.8 | 350.3 | 350.8 |
| 73 | 343.4 | 343.8 | 344.4 | 344.9 | 345.4 | 345.9 | 346.5 | 347.1 | 347.6 | 348.1 | 348.6 | 349.1 | 349.7 | 350.2 | 350.7 | 351.2 | 351.7 | 352.3 | 352.8 | 353.3 |
| 74 | 345.7 | 346.2 | 346.7 | 347.2 | 347.8 | 348.3 | 348.9 | 349.4 | 349.9 | 350.4 | 350.9 | 351.5 | 352.1 | 352.6 | 353.1 | 353.6 | 354.1 | 354.7 | 355.2 | 355.7 |
| 75 | 348.0 | 348.6 | 349.1 | 349.6 | 350.1 | 350.6 | 351.2 | 351.7 | 352.3 | 352.8 | 353.3 | 353.8 | 354.4 | 354.9 | 355.5 | 356.0 | 356.5 | 357.1 | 357.6 | 358.1 |
| 76 | 350.4 | 350.9 | 351.4 | 351.9 | 352.5 | 352.9 | 353.6 | 354.1 | 354.6 | 355.2 | 355.7 | 356.2 | 356.8 | 357.4 | 357.9 | 358.4 | 358.9 | 359.4 | 359.9 | 360.5 |
| 77 | 352.7 | 353.2 | 353.7 | 354.2 | 354.8 | 355.3 | 355.9 | 356.4 | 356.9 | 357.5 | 358.0 | 358.5 | 359.2 | 359.7 | 360.2 | 360.7 | 361.3 | 361.8 | 362.3 | 362.8 |
| 78 | 354.9 | 355.5 | 356.0 | 356.5 | 357.1 | 357.6 | 358.2 | 358.7 | 359.3 | 359.8 | 360.3 | 360.8 | 361.5 | 362.0 | 362.6 | 363.1 | 363.6 | 364.1 | 364.6 | 365.2 |
| 79 | 357.2 | 357.7 | 358.3 | 358.8 | 359.3 | 359.8 | 360.5 | 361.0 | 361.6 | 362.1 | 362.6 | 363.2 | 363.8 | 364.3 | 364.8 | 365.4 | 365.9 | 366.5 | 366.9 | 367.5 |
| 80 | 359.4 | 359.9 | 360.5 | 361.1 | 361.6 | 362.1 | 362.7 | 363.3 | 363.8 | 364.4 | 364.9 | 365.5 | 366.1 | 366.6 | 367.2 | 367.7 | 368.2 | 368.7 | 369.3 | 369.8 |
| 82 | 363.9 | 364.5 | 365.0 | 365.6 | 366.1 | 366.6 | 367.3 | 367.8 | 368.4 | 368.9 | 369.4 | 369.9 | 370.6 | 371.2 | 371.7 | 372.3 | 372.8 | 373.3 | 373.9 | 374.4 |
| 84 | 368.3 | 368.9 | 369.4 | 369.9 | 370.5 | 371.1 | 371.7 | 372.3 | 372.8 | 373.4 | 373.9 | 374.5 | 375.1 | 375.7 | 376.2 | 367.7 | 377.3 | 377.8 | 378.4 | 378.9 |
| 86 | 372.7 | 373.3 | 373.8 | 374.4 | 374.9 | 375.5 | 376.2 | 376.7 | 377.3 | 377.8 | 378.4 | 378.9 | 379.6 | 380.1 | 380.7 | 381.3 | 381.8 | 382.4 | 382.9 | 383.5 |
| 88 | 377.0 | 377.6 | 378.1 | 378.7 | 379.3 | 379.8 | 380.5 | 381.1 | 381.6 | 382.2 | 382.7 | 383.3 | 383.9 | 384.5 | 385.1 | 385.6 | 386.2 | 286.8 | 387.3 | 387.9 |
| 90 | 381.3 | 381.8 | 382.4 | 382.9 | 383.6 | 384.1 | 384.8 | 385.4 | 385.9 | 386.5 | 387.1 | 387.6 | 388.3 | 388.8 | 389.4 | 390.0 | 390.6 | 391.1 | 391.7 | 392.3 |
| 92 | 385.5 | 386.1 | 386.6 | 387.2 | 387.8 | 388.4 | 389.1 | 389.6 | 390.2 | 390.8 | 391.4 | 391.9 | 392.6 | 393.2 | 393.7 | 394.3 | 394.9 | 395.5 | 396.1 | 396.6 |
| 94 | 389.6 | 390.2 | 390.8 | 391.4 | 391.9 | 392.6 | 393.2 | 393.8 | 394.4 | 394.9 | 395.5 | 396.1 | 396.8 | 397.4 | 397.9 | 398.6 | 399.1 | 399.7 | 400.3 | 400.9 |
| 96 | 393.8 | 394.4 | 394.9 | 395.5 | 396.1 | 396.7 | 397.4 | 397.9 | 386.6 | 399.2 | 399.7 | 400.3 | 401.0 | 401.6 | 402.2 | 402.8 | 403.4 | 403.9 | 404.5 | 405.1 |
| 98 | 397.8 | 398.4 | 399.0 | 399.6 | 400.2 | 400.8 | 401.5 | 402.1 | 402.7 | 403.3 | 403.8 | 404.5 | 405.2 | 405.7 | 406.4 | 406.9 | 407.5 | 408.1 | 408.7 | 409.3 |
| 100 | 401.9 | 402.5 | 403.1 | 403.7 | 404.3 | 404.9 | 405.6 | 406.2 | 406.8 | 407.4 | 408.0 | 408.6 | 409.3 | 409.9 | 410.5 | 411.1 | 411.7 | 412.3 | 412.9 | 413.5 |

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

# INDUCTED INTO HARD SERVICE



This battalion of METRIC-AMERICAN Recording Orifice Meters, installed on the field separator, may give some idea of the scope of activities at Continental Oil Company's new Ville Platte (Louisiana) plant. A 8600-horsepower giant which sets new precedents in field stabilization, natural gas recovery and pressure maintenance!

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METRIC METAL WORKS • ERIE, PA.

**AMERICAN**

***METER COMPANY***

INCORPORATED (ESTABLISHED 1836)

## WEIGHT OF DRY MATERIAL ADDED TO DRILLING MUD, LB. PER GAL. (SP. GR. OF ADDITIVE 4.00)

| Original fluid, mud or water | | Desired mud weight, lb. per gal. | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight, lb. per gal. | | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 | 13.5 | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 | 16.5 | 17.0 | 17.5 | 18.0 | 18.5 | 19.0 | 19.5 |
| | Specific gravity | 1.08 | 1.14 | 1.20 | 1.26 | 1.32 | 1.38 | 1.44 | 1.50 | 1.56 | 1.62 | 1.68 | 1.74 | 1.80 | 1.86 | 1.92 | 1.98 | 2.04 | 2.10 | 2.16 | 2.22 | 2.28 | 2.34 |
| *8.345 | 1.00 | 0.92 | 1.66 | 2.34 | 3.17 | 4.01 | 4.84 | 5.76 | 6.67 | 7.51 | 8.68 | 9.76 | 10.9 | 12.1 | 13.4 | 14.7 | 16.2 | 17.7 | 19.2 | 20.8 | 22.9 | 25.0 | 26.8 |
| 9.0 | 1.08 | | 0.75 | 1.42 | 2.17 | 3.00 | 3.84 | 4.67 | 5.59 | 6.59 | 7.59 | 8.59 | 9.76 | 10.9 | 12.2 | 13.4 | 14.0 | 16.4 | 17.8 | 19.6 | 21.4 | 23.3 | 25.4 |
| 9.5 | 1.14 | | | 0.66 | 1.42 | 2.42 | 3.00 | 3.92 | 4.76 | 5.76 | 6.76 | 7.76 | 8.84 | 10.0 | 11.3 | 12.5 | 13.9 | 15.4 | 16.9 | 18.5 | 19.6 | 22.1 | 24.1 |
| 10.0 | 1.20 | | | | 0.75 | 1.50 | 2.25 | 3.17 | 4.00 | 4.92 | 5.92 | 6.93 | 8.01 | 9.18 | 10.0 | 11.7 | 12.5 | 14.2 | 15.9 | 17.5 | 19.2 | 20.9 | 22.5 |
| 10.5 | 1.26 | | | | | 0.75 | 1.50 | 2.34 | 3.17 | 4.09 | 5.09 | 6.01 | 7.9 | 8.18 | 9.18 | 10.8 | 11.7 | 13.4 | 15.0 | 15.9 | 18.4 | 20.0 | 21.7 |
| 11.0 | 1.32 | | | | | | 0.75 | 1.58 | 2.42 | 3.25 | 4.17 | 5.17 | 6.17 | 7.26 | 8.34 | 9.59 | 10.9 | 12.2 | 13.3 | 15.2 | 16.9 | 18.6 | 20.4 |
| 11.5 | 1.38 | | | | | | | 0.75 | 1.59 | 2.50 | 3.34 | 4.34 | 5.34 | 6.34 | 7.51 | 8.68 | 9.93 | 11.3 | 12.6 | 14.2 | 15.7 | 17.4 | 19.3 |
| 12.0 | 1.44 | | | | | | | | 0.83 | 16.7 | 2.50 | 3.42 | 4.42 | 5.34 | 6.51 | 7.68 | 8.93 | 10.2 | 11.5 | 13.1 | 14.6 | 16.3 | 18.1 |
| 12.5 | 1.50 | | | | | | | | | 0.83 | 1.67 | 2.59 | 3.50 | 4.51 | 5.59 | 6.76 | 7.93 | 9.18 | 10.5 | 11.9 | 13.5 | 15.1 | 16.9 |
| 13.0 | 1.56 | | | | | | | | | | 0.83 | 1.75 | 2.67 | 3.67 | 4.67 | 5.76 | 6.93 | 8.18 | 9.51 | 10.8 | 12.4 | 13.9 | 15.7 |
| 13.5 | 1.62 | | | | | | | | | | | 0.83 | 1.75 | 2.75 | 4.09 | 4.84 | 5.92 | 7.18 | 8.43 | 9.76 | 11.3 | 12.8 | 14.4 |
| 14.0 | 1.68 | | | | | | | | | | | | 0.92 | 1.84 | 2.84 | 3.84 | 4.92 | 6.09 | 7.34 | 8.68 | 10.1 | 10.8 | 13.4 |
| 14.5 | 1.74 | | | | | | | | | | | | | 0.92 | 1.84 | 2.92 | 4.01 | 5.09 | 6.34 | 7.59 | 9.01 | 10.5 | 12.1 |
| 15.0 | 1.80 | | | | | | | | | | | | | | 0.92 | 1.92 | 3.00 | 4.17 | 5.26 | 6.51 | 7.84 | 9.35 | 10.8 |
| 15.5 | 1.86 | | | | | | | | | | | | | | | 0.92 | 2.00 | 3.09 | 4.26 | 5.42 | 6.76 | 8.18 | 9.68 |
| 16.0 | 1.92 | | | | | | | | | | | | | | | | 1.00 | 2.00 | 3.17 | 4.34 | 5.59 | 7.01 | 8.43 |
| 16.5 | 1.98 | | | | | | | | | | | | | | | | | 1.00 | 2.09 | 3.25 | 4.51 | 5.84 | 7.26 |
| 17.0 | 2.04 | | | | | | | | | | | | | | | | | | 1.08 | 2.17 | 3.34 | 4.67 | 6.01 |
| 17.5 | 2.10 | | | | | | | | | | | | | | | | | | | 1.08 | 2.25 | 3.50 | 4.84 |
| 18.0 | 2.16 | | | | | | | | | | | | | | | | | | | | 1.08 | 2.34 | 3.59 |
| 18.5 | 2.22 | | | | | | | | | | | | | | | | | | | | | 1.17 | 2.42 |
| 19.0 | 2.28 | | | | | | | | | | | | | | | | | | | | | | 1.17 |

Note: The body of this table supplies the weight in lb. of the dry solid to be added per gal. to drilling fluid of known weight to obtain a mud of higher weight. The above table was calculated with an additive of specific gravity of 4.00.

To use table find weight of original mud in left-hand column and desired mud weight in top line. Multiply figure from body of table by the volume of mud in gal. in well or mud pit to obtain the total amount in lb. of dry material to be added to obtain the desired mud weight.

*Water.

# CUMMINS Dependable DIESELS

## the driller's *dependable* ally

Because every big job is merely the sum of many small jobs, the success of the big job depends upon the efficiency with which the small jobs are done . . . the competence of the men and their allied equipment. America has a big job to do. Ultimate success depends upon the speed and economy with which each one does his own particular job.

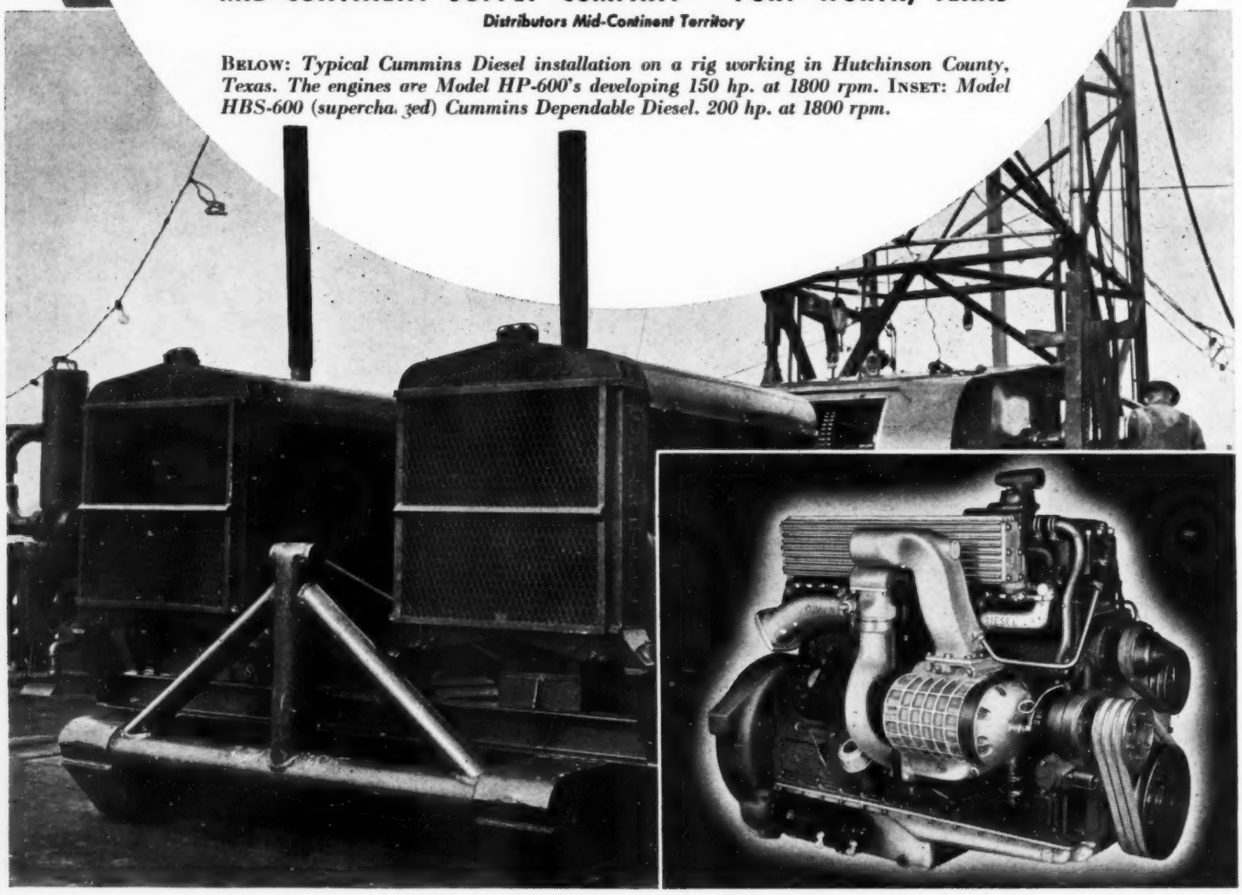
Take drilling for example . . . some years ago, west Texas drillers demonstrated that Cummins Diesel Power was "faster and cheaper than steam." Since then, the Cummins Diesels have saved drilling contractors thousands upon thousands of dollars . . . thousands upon thousands of hours . . . thus they have increased the profit in rotary and cable tool drilling and available working hours of the drilling equipment.

These peace-time tests and user demands for Cummins Diesels in the oil fields developed a dependable ally for the big job we now have on our hands in providing more oil . . . in less time . . . at a lower cost. Cummins Engine Company, Columbus, Indiana.

**MID-CONTINENT SUPPLY COMPANY • FORT WORTH, TEXAS**

*Distributors Mid-Continent Territory*

BELOW: *Typical Cummins Diesel installation on a rig working in Hutchinson County, Texas. The engines are Model HP-600's developing 150 hp. at 1800 rpm.* INSET: *Model HBS-600 (supercharged) Cummins Dependable Diesel. 200 hp. at 1800 rpm.*



# LINE PIPE COEFFICIENTS FOR GAS FLOW—VALUES OF $d^{2.5}$

| Nominal size, in. | Wall Thickness, in. | Lb. per ft. plain ends | Inside diameter, d, in. | $d^{2.5}$ |
|---|---|---|---|---|
| **Steel pipe** | | | | |
| 6⅝ | 0.144 | 9.96 | 6.337 | 101.0903 |
| | 0.169 | 11.65 | 6.287 | 99.1080 |
| | 0.180 | 12.39 | 6.265 | 98.2433 |
| | 0.184 | 12.65 | 6.257 | 97.9299 |
| | 0.185 | 12.72 | 6.255 | 97.8517 |
| | 0.1875 | 12.89 | 6.250 | 97.6562 |
| | 0.203 | 13.92 | 6.219 | 96.4498 |
| | 0.21875 | 14.96 | 6.1875 | 95.2331 |
| | 0.220 | 15.04 | 6.185 | 95.1370 |
| | 0.233 | 15.90 | 6.159 | 94.1403 |
| | 0.245 | 16.69 | 6.135 | 93.2259 |
| 6⅝ | 0.250 | 17.02 | 6.125 | 92.8465 |
| | 0.259 | 17.60 | 6.107 | 92.1658 |
| std. 6 in. (A.P.I.) | 0.280 | 18.97 | 6.065 | 90.5893 |
| | 0.28125 | 19.05 | 6.0625 | 90.4960 |
| | 0.284 | 19.23 | 6.057 | 90.2909 |
| | 0.288 | 19.49 | 6.049 | 89.9931 |
| | 0.292 | 19.75 | 6.041 | 89.6958 |
| | 0.300 | 20.26 | 6.025 | 89.1030 |
| | 0.3125 | 21.06 | 6.000 | 88.1817 |
| | 0.340 | 22.82 | 5.945 | 86.1747 |
| | 0.343 | 23.01 | 5.939 | 85.9574 |
| | 0.352 | 23.58 | 5.921 | 85.3076 |
| | 0.356 | 23.83 | 5.913 | 85.0197 |
| | 0.375 | 25.03 | 5.875 | 83.6604 |
| | 0.385 | 25.65 | 5.855 | 82.9502 |
| | 0.417 | 27.64 | 5.791 | 80.7019 |
| | 0.432 | 28.57 | 5.761 | 79.6608 |
| 7 | 0.149 | 10.90 | 6.702 | 116.2816 |
| | 0.15625 | 11.42 | 6.6875 | 115.6537 |
| | 0.165 | 12.04 | 6.670 | 114.8985 |
| | 0.174 | 12.68 | 6.652 | 114.3880 |
| | 0.180 | 13.11 | 6.640 | 113.6110 |
| | 0.1875 | 13.64 | 6.625 | 112.9704 |
| | 0.203 | 14.73 | 6.594 | 111.6535 |
| | 0.21875 | 15.84 | 6.5625 | 110.5792 |
| | 0.220 | 15.93 | 6.560 | 110.2198 |
| | 0.231 | 16.69 | 6.538 | 109.2955 |
| | 0.238 | 17.18 | 6.524 | 108.7139 |
| | 0.250 | 18.02 | 6.500 | 107.7168 |
| | 0.259 | 18.64 | 6.482 | 106.9726 |
| | 0.272 | 19.54 | 6.456 | 105.9031 |
| | 0.275 | 19.75 | 6.450 | 105.6573 |
| | 0.28125 | 20.18 | 6.4375 | 105.1461 |
| | 0.284 | 20.37 | 6.432 | 104.9214 |
| | 0.300 | 21.46 | 6.400 | 103.6215 |
| | 0.3125 | 22.31 | 6.375 | 102.6126 |
| | 0.332 | 23.64 | 6.336 | 101.0504 |
| | 0.333 | 23.71 | 6.334 | 100.9707 |
| | 0.362 | 25.66 | 6.276 | 98.6750 |
| | 0.393 | 27.73 | 6.214 | 98.4981 |
| | 0.423 | 29.71 | 6.154 | 93.9494 |
| 7⅝ | 0.153 | 12.20 | 7.319 | 144.9203 |
| | 0.165 | 13.14 | 7.295 | 143.7320 |
| | 0.181 | 14.39 | 7.263 | 142.1641 |
| | 0.1875 | 14.89 | 7.250 | 141.5289 |
| | 0.203 | 16.09 | 7.219 | 140.0208 |
| | 0.21875 | 17.30 | 7.1875 | 138.4984 |
| | 0.220 | 17.39 | 7.185 | 138.3780 |
| | 0.238 | 18.77 | 7.149 | 136.6512 |
| | 0.250 | 19.69 | 7.125 | 135.5072 |
| | 0.259 | 20.37 | 7.107 | 134.6529 |
| | 0.28125 | 22.05 | 7.0625 | 132.5551 |
| | 0.284 | 22.26 | 7.057 | 132.2971 |
| | 0.301 | 23.54 | 7.023 | 130.7094 |
| | 0.3125 | 24.40 | 7.000 | 129.6418 |
| | 0.375 | 29.03 | 6.875 | 123.9315 |
| 8 | 0.158 | 13.23 | 7.684 | 163.6698 |
| | 0.165 | 13.80 | 7.670 | 162.9253 |
| | 0.180 | 15.03 | 7.640 | 161.3368 |
| | 0.185 | 15.44 | 7.630 | 160.8093 |
| | 0.186 | 15.52 | 7.628 | 160.7040 |
| | 0.1875 | 15.64 | 7.625 | 160.5460 |
| | 0.203 | 16.90 | 7.594 | 158.9192 |
| | 0.21875 | 18.17 | 7.5625 | 157.2764 |
| | 0.220 | 18.28 | 7.560 | 157.1464 |
| | 0.236 | 19.56 | 7.528 | 155.4888 |
| | 0.238 | 19.73 | 7.524 | 155.2823 |
| | 0.250 | 20.69 | 7.500 | 154.0470 |
| | 0.259 | 21.41 | 7.482 | 153.1244 |
| | 0.28125 | 23.18 | 7.4375 | 150.8577 |
| | 0.284 | 23.40 | 7.432 | 150.5790 |
| | 0.300 | 24.67 | 7.400 | 148.9633 |
| | 0.307 | 25.22 | 7.386 | 148.2598 |
| | 0.3125 | 25.65 | 7.375 | 147.7084 |
| | 0.375 | 30.53 | 7.250 | 141.5289 |
| 8⅝ | 0.165 | 14.90 | 8.295 | 198.1714 |
| | 0.180 | 16.23 | 8.265 | 196.3845 |

| Nominal size, in. | Wall Thickness, in. | Lb. per ft. plain ends | Inside diameter, d, in. | $d^{2.5}$ |
|---|---|---|---|---|
| **Steel pipe** | | | | |
| | 0.1875 | 16.89 | 8.250 | 195.4946 |
| | 0.203 | 18.25 | 8.219 | 193.6634 |
| | 0.217 | 19.48 | 8.191 | 192.0182 |
| | 0.21875 | 19.63 | 8.1875 | 191.8131 |
| | 0.220 | 19.74 | 8.185 | 191.6668 |
| | 0.238 | 21.31 | 8.149 | 189.5662 |
| | 0.250 | 22.36 | 8.125 | 188.1735 |
| | 0.259 | 23.14 | 8.107 | 187.1336 |
| | 0.264 | 23.57 | 8.097 | 186.5565 |
| A.P.I. 8 in. | 0.277 | 24.70 | 8.071 | 185.0624 |
| | 0.28125 | 25.06 | 8.0625 | 184.5756 |
| | 0.284 | 25.29 | 8.057 | 184.2610 |
| | 0.300 | 26.67 | 8.025 | 182.4368 |
| | 0.304 | 27.01 | 8.021 | 182.2096 |
| | 0.311 | 27.61 | 8.003 | 181.1891 |
| | 0.3125 | 27.74 | 8.000 | 181.0193 |
| | 0.322 | 28.55 | 7.981 | 179.9464 |
| | 0.340 | 30.08 | 7.945 | 177.9241 |
| 8⅝ | 0.34375 | 30.40 | 7.9375 | 177.5045 |
| | 0.352 | 31.10 | 7.921 | 176.5835 |
| | 0.354 | 31.27 | 7.917 | 176.3606 |
| | 0.375 | 33.04 | 7.875 | 174.0310 |
| | 0.400 | 35.13 | 7.825 | 171.2816 |
| | 0.40625 | 35.65 | 7.8125 | 170.5984 |
| | 0.425 | 37.22 | 7.775 | 168.5586 |
| | 0.4375 | 38.25 | 7.750 | 167.2069 |
| | 0.487 | 42.32 | 7.651 | 161.9181 |
| | 0.500 | 43.38 | 7.625 | 160.5460 |
| 9 | 0.167 | 15.75 | 8.666 | 221.0786 |
| | 0.180 | 16.95 | 8.640 | 219.4341 |
| | 0.1875 | 17.64 | 8.625 | 218.4730 |
| | 0.196 | 18.42 | 8.608 | 217.3981 |
| | 0.203 | 19.07 | 8.594 | 216.5152 |
| | 0.21875 | 20.51 | 8.5625 | 214.5367 |
| | 0.220 | 20.62 | 8.560 | 214.3801 |
| | 0.238 | 22.27 | 8.524 | 212.3801 |
| | 0.250 | 23.36 | 8.500 | 210.6431 |
| | 0.259 | 24.17 | 8.482 | 209.5298 |
| | 0.28125 | 26.18 | 8.4375 | 206.7924 |
| | 0.284 | 26.43 | 8.432 | 206.4555 |
| | 0.300 | 27.87 | 8.400 | 204.5023 |
| | 0.3125 | 28.99 | 8.375 | 202.9841 |
| | 0.355 | 32.77 | 8.290 | 197.8729 |
| | 0.375 | 34.54 | 8.250 | 195.4946 |
| | 0.402 | 36.91 | 8.196 | 192.3112 |
| | 0.425 | 38.92 | 8.150 | 189.6243 |
| | 0.484 | 44.02 | 8.032 | 182.8350 |
| | 0.500 | 45.39 | 8.000 | 181.0193 |
| 9⅝ | 0.171 | 17.26 | 9.283 | 262.5554 |
| | 0.180 | 18.15 | 9.265 | 261.2844 |
| | 0.1875 | 18.89 | 9.250 | 260.2281 |
| | 0.203 | 20.42 | 9.221 | 258.1933 |
| | 0.21875 | 21.97 | 9.1875 | 255.8548 |
| | 0.220 | 22.09 | 9.185 | 255.6807 |
| | 0.238 | 23.86 | 9.149 | 253.1827 |
| | 0.250 | 25.03 | 9.125 | 251.5257 |
| | 0.259 | 25.90 | 9.107 | 250.2870 |
| | 0.28125 | 28.06 | 9.0625 | 247.2407 |
| | 0.284 | 28.33 | 9.057 | 246.8659 |
| | 0.300 | 29.87 | 9.025 | 244.6910 |
| | 0.3125 | 31.08 | 9.000 | 243.0000 |
| | 0.340 | 33.71 | 8.945 | 239.3045 |
| | 0.342 | 33.90 | 8.941 | 239.0371 |
| | 0.375 | 37.04 | 8.875 | 234.6502 |
| | 0.4375 | 42.92 | 8.750 | 226.4750 |
| | 0.500 | 48.72 | 8.625 | 218.4730 |
| 10 | 0.175 | 18.36 | 9.650 | 289.2800 |
| | 0.180 | 18.87 | 9.640 | 288.5310 |
| | 0.1875 | 19.64 | 9.625 | 287.4100 |
| | 0.203 | 21.24 | 9.594 | 285.1014 |
| | 0.208 | 21.75 | 9.584 | 284.3590 |
| | 0.209 | 21.85 | 9.582 | 284.2107 |
| | 0.21875 | 22.85 | 9.5625 | 282.7669 |
| | 0.220 | 22.97 | 9.560 | 282.5822 |
| | 0.238 | 24.81 | 9.524 | 279.9294 |
| | 0.250 | 26.03 | 9.500 | 278.1692 |
| | 0.259 | 26.94 | 9.482 | 276.8535 |
| | 0.270 | 28.05 | 9.460 | 275.2503 |
| | 0.28125 | 29.19 | 9.4375 | 273.6166 |
| | 0.283 | 29.36 | 9.434 | 273.3630 |
| | 0.284 | 29.47 | 9.432 | 273.2181 |
| | 0.300 | 31.07 | 9.400 | 270.9068 |
| | 0.308 | 31.88 | 9.384 | 269.7553 |
| | 0.3125 | 32.33 | 9.375 | 269.1091 |
| | 0.340 | 35.07 | 9.320 | 265.1794 |
| | 0.375 | 38.54 | 9.250 | 260.2281 |
| | 0.4375 | 44.68 | 9.125 | 251.5257 |
| | 0.500 | 50.73 | 9.000 | 243.0000 |

This group of tables was prepared by P. McDonald Biddison in connection with the article, "Computing Gas Flow in Pipe Lines," published in the August, September, and October, 1941, issues of *The Petroleum Engineer*.

As the general equation for the flow of gas in long lines involves a knowledge of the exact value of the internal diameter of the pipe, d, raised to the 2.5 power, these tables should facilitate flow calculations.

See sheet 5, column 2, of this series (P 622.001.) for similar data on cast iron pipe.

*"My boss wasn't kidding when he said he didn't have time to teach me. Yet, with the plant going night and day, I'm being called on more and more to use my own judgment in handling maintenance. That's big responsibility for new men—with piping so important. But I'm catching on—with the help of these Crane Piping Pointer Bulletins."*

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NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

# LINE PIPE COEFFICIENTS FOR GAS FLOW—VALUES OF $d^{2.5}$

| Nominal size, in. | Wall Thickness, in. | Lb. per ft. plain ends | Inside diameter, d, in. | $d^{2.5}$ |
|---|---|---|---|---|
| **Steel pipe** | | | | |
| 10¾ | 0.180 | 20.32 | 10.390 | 347.9676 |
| | 0.203 | 22.86 | 10.344 | 344.1294 |
| | 0.21875 | 24.60 | 10.3125 | 341.5152 |
| | 0.220 | 24.74 | 10.310 | 341.3083 |
| | 0.238 | 26.72 | 10.274 | 338.3366 |
| | 0.250 | 28.03 | 10.250 | 336.3642 |
| | 0.259 | 29.01 | 10.232 | 334.8898 |
| | 0.279 | 31.20 | 10.192 | 331.6260 |
| | 0.28125 | 31.44 | 10.1875 | 331.2598 |
| | 0.284 | 31.74 | 10.182 | 330.8139 |
| | 0.300 | 33.48 | 10.150 | 328.2200 |
| | 0.302 | 33.69 | 10.146 | 327.8969 |
| | 0.307 | 34.24 | 10.136 | 327.0894 |
| | 0.3125 | 34.83 | 10.125 | 326.2026 |
| | 0.348 | 38.66 | 10.054 | 320.5142 |
| | 0.365 | 40.48 | 10.020 | 317.8113 |
| | 0.375 | 41.55 | 10.0000 | 316.2278 |
| | 0.395 | 43.68 | 9.960 | 313.0749 |
| | 0.400 | 44.21 | 9.950 | 312.2891 |
| | 0.424 | 46.76 | 9.902 | 308.5370 |
| | 0.450 | 49.50 | 9.850 | 304.5022 |
| | 0.483 | 52.96 | 9.784 | 299.4270 |
| | 0.495 | 54.21 | 9.760 | 297.5942 |
| | 0.500 | 54.73 | 9.750 | 296.8325 |
| 11 | 0.185 | 21.36 | 10.630 | 368.4116 |
| | 0.203 | 23.40 | 10.594 | 363.2035 |
| | 0.21875 | 25.18 | 10.5625 | 362.5910 |
| | 0.220 | 25.32 | 10.560 | 362.3763 |
| | 0.224 | 25.78 | 10.552 | 361.6904 |
| | 0.238 | 27.35 | 10.524 | 359.2957 |
| | 0.250 | 28.70 | 10.500 | 357.2509 |
| | 0.259 | 29.71 | 10.482 | 355.7218 |
| | 0.28125 | 32.19 | 10.4375 | 351.9584 |
| | 0.284 | 32.50 | 10.432 | 352.3052 |
| | 0.290 | 33.17 | 10.420 | 350.4850 |
| | 0.300 | 34.28 | 10.400 | 348.8055 |
| | 0.3125 | 35.67 | 10.375 | 346.7131 |
| | 0.340 | 38.70 | 10.320 | 342.1364 |
| | 0.375 | 42.55 | 10.250 | 336.3642 |
| | 0.4375 | 49.35 | 10.125 | 326.2026 |
| | 0.500 | 56.07 | 10.000 | 316.2278 |
| 11¾ | 0.189 | 23.33 | 11.372 | 436.1063 |
| | 0.203 | 25.03 | 11.344 | 433.4265 |
| | 0.21875 | 26.94 | 11.3125 | 430.4241 |
| | 0.220 | 27.09 | 11.310 | 430.1862 |
| | 0.238 | 29.26 | 11.274 | 426.7711 |
| | 0.250 | 30.70 | 11.250 | 424.5035 |
| | 0.259 | 31.78 | 11.232 | 422.8076 |
| | 0.28125 | 34.44 | 11.1875 | 418.6324 |
| | 0.284 | 34.77 | 11.182 | 418.1180 |
| | 0.300 | 36.68 | 11.150 | 415.1330 |
| | 0.3125 | 38.17 | 11.125 | 412.8098 |
| | 0.340 | 41.43 | 11.070 | 407.7265 |
| | 0.34375 | 41.87 | 11.0625 | 407.0364 |
| | 0.375 | 45.55 | 11.000 | 401.3117 |
| | 0.345 | 52.56 | 10.880 | 390.4562 |
| | 0.500 | 60.07 | 10.750 | 378.8971 |
| 12 | 0.180 | | 11.640 | 462.2560 |
| | 0.185 | | 11.630 | 461.2637 |
| | 0.1875 | | 11.625 | 460.7682 |
| | 0.189 | | 11.622 | 460.4711 |
| | 0.194 | 24.46 | 11.612 | 459.4810 |
| | 0.203 | 25.57 | 11.594 | 457.7025 |
| | 0.21875 | 27.52 | 11.5625 | 454.6000 |
| | 0.220 | 27.67 | 11.560 | 454.3542 |
| | 0.229 | 28.78 | 11.542 | 452.5877 |
| | 0.238 | 29.89 | 11.524 | 450.8250 |
| | 0.243 | 30.51 | 11.514 | 449.8477 |
| | 0.244 | 30.63 | 11.512 | 449.6525 |
| | 0.250 | 31.37 | 11.500 | 448.4814 |
| | 0.259 | 32.47 | 11.482 | 444.1645 |
| | 0.28125 | 35.20 | 11.4375 | 442.4130 |
| | 0.284 | 35.53 | 11.432 | 441.8812 |
| | 0.292 | 36.51 | 11.416 | 440.3368 |
| | 0.300 | 37.48 | 11.400 | 438.7957 |
| | 0.308 | 38.46 | 11.384 | 437.2575 |
| | 0.310 | 38.70 | 11.380 | 436.8736 |
| | 0.3125 | 39.00 | 11.375 | 436.3937 |
| | 0.320 | 39.91 | 11.360 | 434.9565 |
| | 0.340 | 42.34 | 11.320 | 431.1377 |
| | 0.34375 | 42.79 | 11.3125 | 430.4241 |
| | 0.375 | 46.55 | 11.250 | 424.5035 |
| | 0.4375 | 54.02 | 11.125 | 412.8098 |
| | 0.500 | 61.41 | 11.000 | 401.3117 |
| 12¾ | 0.180 | | 12.390 | 540.3539 |
| | 0.185 | | 12.380 | 539.2641 |
| | 0.1875 | | 12.375 | 538.7200 |
| | 0.189 | | 12.372 | 538.3935 |
| | 0.194 | | 12.362 | 537.3062 |
| | 0.203 | 27.20 | 12.344 | 535.3525 |
| | 0.21875 | 29.27 | 12.3125 | 531.9440 |
| | 0.220 | 29.44 | 12.310 | 531.6738 |
| **Steel pipe** | 0.238 | | 12.274 | 527.7950 |
| 12¾ | 0.250 | | 12.250 | 525.2188 |
| | 0.259 | | 12.232 | 522.9302 |
| | 0.28125 | 37.45 | 12.1875 | 518.5451 |
| | 0.284 | 37.81 | 12.182 | 517.9604 |
| | 0.300 | 39.89 | 12.150 | 514.5656 |
| | 0.3125 | 41.51 | 12.125 | 511.9226 |
| | 0.330 | 43.77 | 12.090 | 508.2365 |
| | 0.340 | 45.06 | 12.070 | 506.1372 |
| | 0.34375 | 45.54 | 12.0625 | 505.3512 |
| | 0.375 | 49.56 | 12.000 | 498.8305 |
| | 0.4375 | 57.53 | 11.875 | 485.9416 |
| | 0.500 | 65.41 | 11.750 | 473.2546 |
| 13 | 0.180 | | 12.640 | 568.0255 |
| | 0.185 | | 12.630 | 566.9026 |
| | 0.1875 | | 12.625 | 566.3417 |
| | 0.189 | | 12.622 | 566.0053 |
| | 0.194 | | 12.612 | 564.8850 |
| | 0.202 | 27.61 | 12.596 | 563.0952 |
| | 0.203 | 27.74 | 12.594 | 562.8716 |
| | 0.21875 | 29.86 | 12.5625 | 559.3586 |
| | 0.220 | 30.02 | 12.560 | 559.0800 |
| | 0.238 | 32.43 | 12.524 | 555.0828 |
| | 0.247 | 33.64 | 12.506 | 553.0903 |
| | 0.250 | 34.04 | 12.500 | 552.4271 |
| | 0.259 | 35.24 | 12.482 | 550.4406 |
| | 0.281 | 38.17 | 12.438 | 545.6027 |
| | 0.284 | 38.56 | 12.432 | 544.9448 |
| | 0.300 | 40.69 | 12.400 | 541.4450 |
| | 0.310 | 42.01 | 12.380 | 539.2641 |
| | 0.3125 | 42.34 | 12.375 | 538.7200 |
| | 0.320 | 43.33 | 12.360 | 537.0890 |
| | 0.340 | 45.97 | 12.320 | 532.7541 |
| | 0.34375 | 46.46 | 12.3125 | 531.9440 |
| | 0.359 | 48.46 | 12.282 | 528.6555 |
| | 0.361 | 48.73 | 12.278 | 528.2250 |
| | 0.375 | 50.56 | 12.250 | 525.2188 |
| | 0.390 | 52.52 | 12.220 | 522.0090 |
| | 0.4375 | 58.69 | 12.125 | 511.9226 |
| | 0.500 | 66.75 | 12.000 | 498.8305 |
| 14 | 0.180 | | 13.640 | 687.1254 |
| | 0.185 | | 13.630 | 685.8668 |
| | 0.1875 | | 13.625 | 685.2378 |
| | 0.189 | | 13.622 | 684.8608 |
| | 0.194 | | 13.612 | 683.6043 |
| | 0.203 | | 13.594 | 681.3469 |
| | 0.210 | 30.92 | 13.580 | 679.5939 |
| | 0.21875 | 32.19 | 13.5625 | 677.4067 |
| | 0.220 | 32.37 | 13.560 | 677.0945 |
| | 0.238 | 34.98 | 13.524 | 672.6095 |
| | 0.248 | 36.42 | 13.504 | 670.1252 |
| | 0.250 | 36.71 | 13.500 | 669.6294 |
| | 0.259 | 38.00 | 13.482 | 667.3994 |
| | 0.276 | 40.45 | 13.448 | 663.1997 |
| | 0.28125 | 41.20 | 13.4375 | 661.9060 |
| | 0.284 | 41.60 | 13.432 | 661.2289 |
| | 0.300 | 43.89 | 13.400 | 657.2976 |
| | 0.310 | 45.32 | 13.380 | 654.8477 |
| | 0.3125 | 45.68 | 13.375 | 654.2361 |
| | 0.328 | 47.89 | 13.344 | 650.4516 |
| | 0.340 | 49.60 | 13.320 | 647.5309 |
| | 0.34375 | 50.13 | 13.3125 | 646.6199 |
| | 0.375 | 54.57 | 13.250 | 639.0574 |
| A.P.I. 14 in. | 0.40625 | 58.98 | 13.1875 | 627.9229 |
| | 0.4375 | 63.37 | 13.125 | 620.5093 |
| | 0.46875 | 67.74 | 13.0625 | 613.1487 |
| | 0.500 | 72.09 | 13.000 | 609.3383 |
| 15 | 0.180 | | 14.640 | 820.0736 |
| | 0.185 | | 14.630 | 818.6736 |
| | 0.1875 | | 14.625 | 817.9745 |
| | 0.189 | | 14.622 | 817.5551 |
| | 0.194 | | 14.612 | 816.1581 |
| | 0.203 | | 14.594 | 813.6466 |
| | 0.21875 | | 14.5625 | 809.2632 |
| | 0.222 | 35.03 | 14.556 | 808.3604 |
| | 0.238 | 37.52 | 14.524 | 803.9250 |
| | 0.250 | 39.38 | 14.500 | 800.6081 |
| | 0.259 | 40.77 | 14.482 | 798.1257 |
| | 0.260 | 40.93 | 14.480 | 797.8505 |
| | 0.28125 | 44.21 | 14.4375 | 792.0187 |
| | 0.284 | 44.63 | 14.432 | 791.2547 |
| | 0.291 | 45.71 | 14.418 | 789.3371 |
| | 0.300 | 47.09 | 14.400 | 786.8760 |
| | 0.3125 | 49.02 | 14.375 | 783.4653 |
| | 0.320 | 50.17 | 14.360 | 781.4227 |
| | 0.340 | 53.23 | 14.320 | 775.9925 |
| | 0.34375 | 53.80 | 14.3125 | 774.9770 |
| A.P.I. 15 in. | 0.375 | 58.57 | 14.250 | 766.5444 |
| | 0.40625 | 63.31 | 14.1875 | 758.1670 |
| | 0.4375 | 68.04 | 14.125 | 749.8447 |
| | 0.46875 | 72.74 | 14.0625 | 737.3210 |
| | 0.500 | 77.43 | 14.000 | 733.3647 |
| | 0.5625 | 86.73 | 13.875 | 717.1046 |

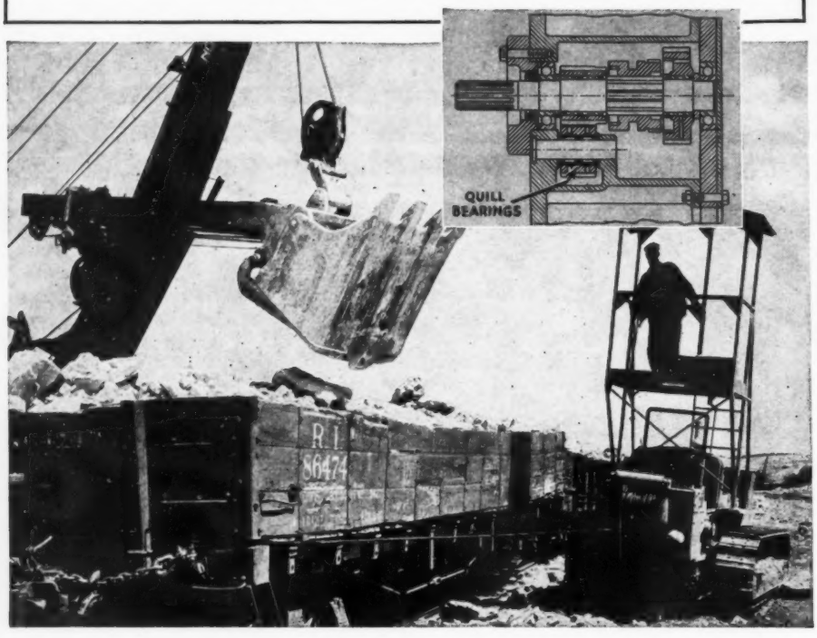
This group of tables was prepared by P. McDonald Biddison in connection with the article, "Computing Gas Flow in Pipe Lines," published in the August, September, and October, 1941, issues of *The Petroleum Engineer*.

As the general equation for the flow of gas in long lines involves a knowledge of the exact value of the internal diameter of the pipe, d, raised to the 2.5 power, these tables should facilitate flow calculations.

See sheet 5, column 2, of this series (P 622.001.) for similar data on cast iron pipe.

# IN THE NEWS

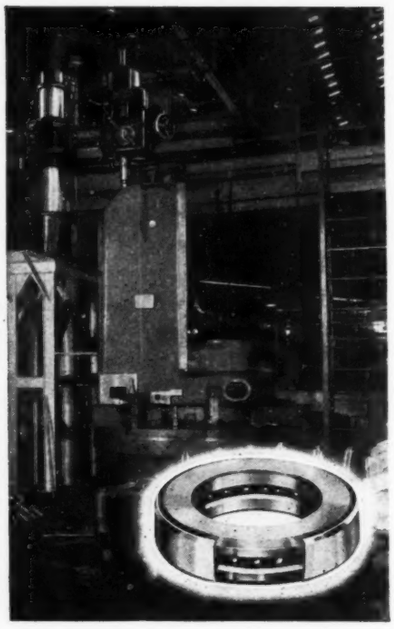
## WITH BANTAM BEARINGS



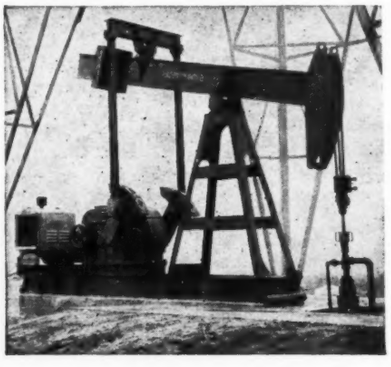

**REPLACING A LOCOMOTIVE** is all in a day's work for this worm drive towing winch used to move freight cars into position to facilitate even loading. Built by Willamette Hyster Company, it employs Bantam Quill Bearings in the idler gears of the transmission. As shown in the drawing, these compact Quill Bearings are particularly well adapted to the limited clearances available. And, in addition, the high load capacity of Quill Bearings aids the Hyster Winch in handling tough jobs efficiently and with minimum power loss.

**IN THE GIGANTIC TASK** of moving America at war—"Freightliners" are providing swift, safe convoy for raw materials, munitions, supplies and equipment. Built by Freightways Manufacturing Company, these dual trailer units use Bantam Quill Bearings for long, dependable service.

**PROMPT DELIVERY OF SPECIAL BEARINGS** is offered by Bantam because Bantam is tooled-up to manufacture made-to-order bearings with a minimum of delay. And the cooperation of Bantam's engineers is available to aid you in the design of such bearings. Or, if you have a standard application, remember that Bantam makes every major type of anti-friction bearing—straight roller, tapered roller, needle and ball. No matter how urgent your need or difficult your problem, for experienced engineering counsel or for prompt deliveries on essential jobs—TURN TO BANTAM.



**THE BACKBONE OF INDUSTRY** are machine tools such as the radial drill shown here, mounted on a platform for high altitude work in the plant of one of the Nation's largest machine manufacturers. Made by the Morris Machine Tool Company, this drill uses Bantam Radial Ball Bearings—a typical example of Bantam's service in the design and engineering of bearings for all types of applications.



**VICTORY OR DEFEAT** in this war may depend on oil. Pumping units like this one, built by The Happy Company, are operating on a 24-hour basis to supply this vital source of power for American planes, tanks, and trucks. To assure efficient operation and long service life with a minimum of attention, Bantam Quill Bearings are used in equalizers, center iron saddles, other points of wear. The high unit capacity of these low-cost anti-friction bearings also helps simplify design.

**BANTAM BEARINGS**

**STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL**

**BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA**

# Determining Fuel Oil Heat Losses

PETROLEUM ENGINEER Exclusive Feature

*by W. F. Schaphorst*

SEVERAL years ago a chart prepared by the writer on fuel heat losses was published similar to the one shown herewith, arousing unusual interest. That chart related only to coal, however, and by request has been converted to oil as many concerns are burning oil and think only in terms of oil. Also, the writer has been asked to give the formula on which the chart is based. The formula is as follows:

$$L = \frac{0.08\ (5\ CO_2 + 700)\ C\ (T - t)}{CO_2\ H}$$

Where:

- L = percentage of fuel loss
- $CO_2$ = percentage of carbon dioxide
- C = percentage of carbon in the fuel
- T = temperature of outgoing flue gas, commonly called "chimney gas temperature"
- t = temperature of air entering the furnace
- H = B.t.u. per lb. of fuel.

Based on this formula, the accompanying chart, in terms of fuel oil, has been prepared.

Let us now cite some examples showing how the chart "works."

*Example:*

The heat value of fuel oil used under given boilers is 18,000 B.t.u. per lb.; 88 percent of the oil is carbon; the flue gas contains 7 percent $CO_2$; the outgoing flue gas temperature is 600°F., and the temperature of the air entering the furnace is 75°F. What is the heat loss up the chimney due to low $CO_2$ and the temperature rise of (600—75) 525°F.?

Applying the chart, the dotted lines show the solution of the problem as follows: Run a straight line through the 18,000 B.t.u., column A, and the 88 percent carbon, column B, and find the intersection in column C. Then run a line through that point in column C and the 7 percent $CO_2$ in column D, finding a point in column E. Then run a line through that point in column E and the 525°F. difference, column F, and the intersection with column G shows the fuel loss to be 21.5 percent.

## With Conditions Improved

Suppose now that furnace conditions are improved to the extent that $CO_2$ becomes 12 percent and flue gas temperature is reduced to 500°F. Temperature of air entering the furnace is still 75°F., hence the "difference," column F, is 425°F.

Applying the chart the same point in column C is determined as already instructed. Then run a straight line through that point and the 12 percent $CO_2$ in column D finding a new point in column E. From this latter point run through the 425 in column F and the fuel loss, column G, is found to be 10.5 percent.

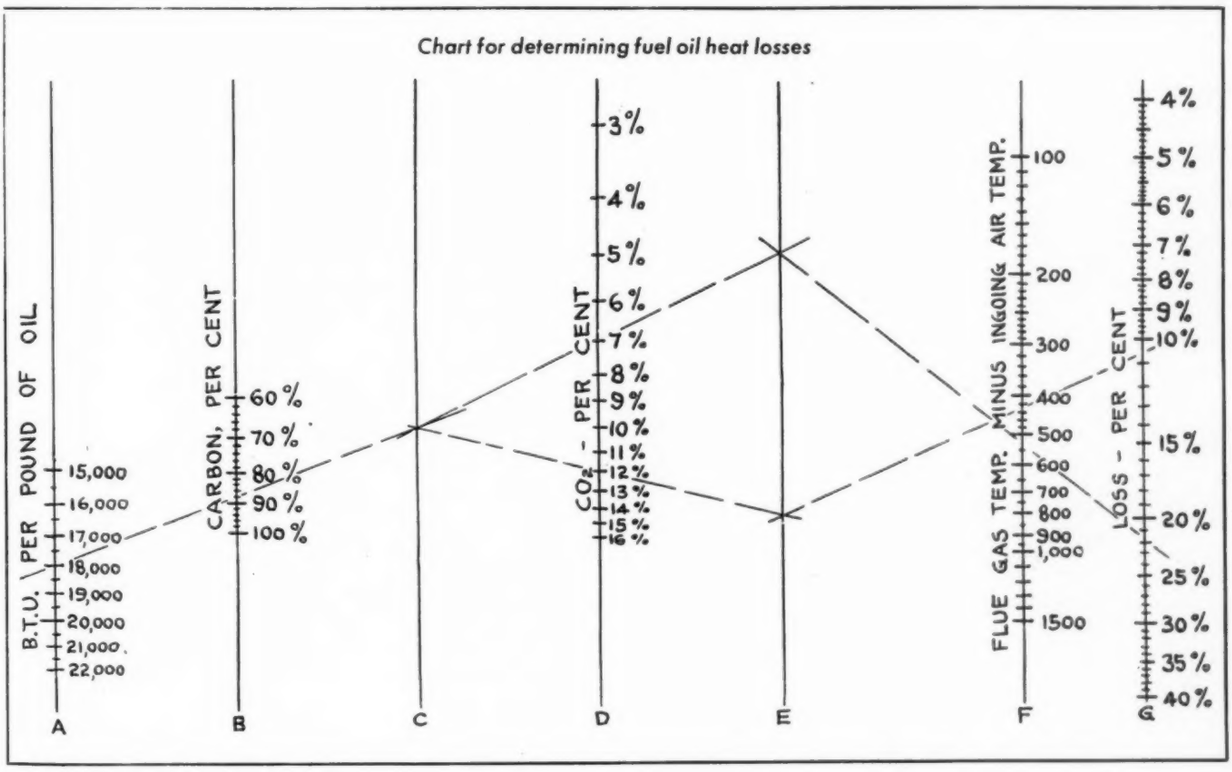
## Saving of Fuel Oil

It is now clear that the saving in oil fuel due to improvement in conditions is the difference between the two losses, namely, 21.5 percent — 10.5 percent = 11 percent saving.

As a "double check" on these results the above formula may be applied. It will be found that the formula and the chart agree closely.

☆☆☆

*Chart for determining fuel oil heat losses*



# Running Tour

## WITH MEN IN THE INDUSTRY

ROBERT W. HARRISON, petroleum engineer with Foran, Boatright and Dixon, consulting petroleum and natural gas engineers, Houston, Texas, has resigned to assume duties with the U. S. Army Corps of Engineers as first lieutenant. He is stationed at Fort Logan, Denver, Colorado.

JACK VESTAL of Arkadelphia, Arkansas, a student at the University of Oklahoma petroleum engineering school, has been employed as a junior engineer by the Arkansas Oil and Gas Commission. J. R. HARRISON of Aransas Pass, Texas, has been employed as a natural gas engineer. He is a graduate of Texas A. and I. College. ARTHUR G. BURKI, Pittsburgh, Pennsylvania, graduate of the University of Pittsburgh, has been employed as a petroleum engineer. These engineers were employed to fill vacancies created by men leaving to join the armed forces of the United States.

J. HOWARD WADDLE, division engineer of the Arkansas Oil and Gas Commission, with offices in Magnolia, Arkansas, has resigned to accept a position with the Standard Oil Company of New Jersey subsidiary, the McKamie Gas Cleaning Company. He will be engineer in charge of construction and operation of the plant, the first large-scale gas purification plant in the sour gas area of Arkansas.

W. J. CRITES, engineer in the production department of Phillips Petroleum Company, Bartlesville, Oklahoma, passed away June 2 after an illness of three weeks. He was 59 years old.

S. J. TAYLOR, assistant district geologist in the West Texas area for Seaboard Oil Company, has been transferred from Midland to Corpus Christi. He will be assistant district geologist of the Southwest Texas district.

GONZALO ACOSTA, engineer, has been sent by The Texas Company from Fort Worth, Texas, to Bogota, Colombia.

C. G. ADAMS, geologist, has been transferred from Dodge City, Kansas, to Lusk, Wyoming, by The Texas Company.

LEO I. MULLANEY, engineer with The Texas-Empire Pipe Line Company, has been transferred from Pana to Coal City, Illinois.

DAVID M. LOGAN, liaison officer in Oklahoma for region 2, The Office of Petroleum Coördinator for War, now has his offices at 501 Federal Building, Oklahoma City, Oklahoma.

THOMAS J. THORLEY, for six years an engineer with Martin-Decker Corporation, Long Beach, California, has been commissioned a lieutenant junior

THOMAS J. THORLEY

grade by the U. S. Naval Reserve. Thorley graduated from the University of Southern California in 1936 with a degree in general engineering. He is a member of the American Petroleum Institute and the American Institute of Mining and Metallurgical Engineers.

J. J. BENTON, construction superintendent in the Dutch East Indies for the Standard Oil Company of New Jersey, is visiting in the United States. He assisted in destroying wells and refineries in Sumatra to prevent them falling into Japanese hands.

PHILEMON DICKERSON of Pawhuska, Oklahoma, has accepted a position in Peru with a subsidiary of the Standard Oil Company of New Jersey.

E. V. FORAN of Foran, Boatright and Dixon, consulting engineers, Houston, Texas, has received a commission in the United States Navy.

O. Q. LOMAX has been elected vice-president and general superintendent of the Humble Pipe Line Company, Houston, Texas, to succeed J. A. NEATH, who recently was made a member of the board of directors of the Humble Oil and Refining Company.

Other changes in management are announced as follows:

F. D. MCMAHON, formerly division superintendent at Longview, Texas, has been transferred to Houston as assistant general superintendent.

H. M. STEVENSON, formerly chief engineer, has been made chief engineer and assistant to general superintendent at Houston.

G. A. LEE, formerly assistant division superintendent in West Texas, has been made division superintendent of East Texas at Longview.

JACK JONES, formerly superintendent of West Texas division at Odessa, has been made assistant division superintendent of West Texas and Panhandle division at Midland.

A. J. MULLER, formerly district superintendent of the Panhandle area at Pampa, has been made West Texas district superintendent at Odessa.

H. V. MCCORKLE, formerly division warehouseman and relief district superintendent in West Texas, has been transferred to Pampa as district superintendent.

T. RIEBER, at one time chairman of the board of The Texas Company, has been made president of the Barber Asphalt Company, to succeed FRANK SEAMANS who retired after 50 years' service.

A. F. ALLEN, secretary-treasurer of the American Steel and Wire Company, has announced his retirement after 52 years' service with United States Steel Corporation companies and their predecessors.

HOWARD A. COWDEN, president of the Consumers Coöperative Association, Kansas City, Kansas, has accepted an appointment by Price Administrator Leon Henderson to a national petroleum advisory committee concerned with oil price control.

E. H. POE, secretary of the Natural Gas Department of the American Gas Association, has been appointed chief of the natural gas and gasoline division in the Office of Petroleum Coördinator.

DR. C. M. LARSON of the Sinclair Refining Company spoke recently on aviation oils at a joint meeting in Bradford, Pennsylvania, of the departments of manufacture and standards and tests of the National Petroleum Association.

# FLUPACOS

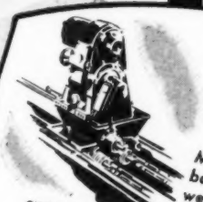
# "Keep 'em pumpin'"

## without replacements!

**HERE'S GOOD NEWS for you pump users faced with a serious maintenance problem—the problem of replacing pump parts . . . making costly repairs . . . securing hard-to-get new equipment:**

Field performance reports show that the new Flupaco *full-length* Hardened and Honed pump barrel is one of the biggest helps EVER developed for *cutting your pump wear.* From 8 to 10 times *harder* on their wearing surfaces (64-70 Rockwell C) than ordinary untreated types, they're giving 2 to 5 times longer service life on many installations. Furthermore, the single piece barrel construction does away with multiple cast liners, jackets, and other extras of jointed barrel design, cutting out excessive bulk and reducing weight to as little as one-fourth that of the pumps new Flupacos are replacing.

Not only does the barrel give many times more wear, but also smoother pump operation. The uniformly hardened, precision-honed barrel provides the ideal surface for plunger operation. It won't misalign in service, won't bind the plunger or cause understroking . . . only a few of the common and costly pump troubles that Flupaco barrels prevent.



### REHONING EXTENDS BARREL LIFE

MORE GOOD NEWS: Flupaco barrels have a deep inside wearing surface and a hard outer surface, adequately supported by a tough, ductile core between that eliminates brittleness and provides extra strength for the severe tensile or bending strains of the toughest jobs. And the inside wearing surface can be economically re-honed numerous times to give more months of trouble-free pump service!

**Flupaco "Improved Insert" and "Groove Seal" Pumps are stocked ready for delivery in sizes, types, and metals for a range of installation needs. See your Fluid Packed representative—or write us direct!**

## FLUID PACKED PUMP CO.

BOX 64, LOS NIETOS, CALIFORNIA

2 S. E. 29th STREET, OKLAHOMA CITY, OKLAHOMA ★ HUNT BUILDING, TULSA, OKLAHOMA

2301 CONGRESS AVENUE, HOUSTON, TEXAS

RAY MILLER, vice-president of Hanlon-Buchanan, Inc., Tulsa, Oklahoma, has been reelected president of the Natural Gasoline Association of America. Other officers chosen at the recent annual meeting are: H. H. BEESON, Sabine Valley Gasoline Company, Shreveport, Louisiana, H. A. EELLS, Cities Service Oil Company, Bartlesville, Oklahoma, J. R. JARVIS, Lone Star Gasoline Company, Dallas, Texas, and J. W. VAIDEN, Skelly Oil Company, Tulsa, Oklahoma, all vice-presidents; W. F. LOWE, secretary-treasurer, and C. R. WILLIAMS, The Chicago Corporation, Corpus Christi, Texas, vice-president of the high-pressure gas division.

P. F. BROWN, vice-president of the Honolulu Oil Corporation in charge of West Texas operations, has been elected a member of the board of directors.

W. H. STUEVE of the Oklahoma Gas and Electric Company, Oklahoma City, Oklahoma, has been elected president of the Oklahoma City Engineering Club.

W. L. STEWART, JR., was elected executive vice-president of the Union Oil Company of California after directors of the company approved lending the services of REESE H. TAYLOR, president, to head the iron and steel division of WPB. Prior to joining the Union Oil Company Taylor was president of the Consolidated Steel Corporation.

GLEN S. DILLE, independent geologist, has been elected president of the Tulsa Geological Society. Other officers include MAURICE R. TEIS, Ohio Oil Company, first vice-president; MYRON C. KEISS, Pure Oil Company, second vice-president; LOUIS DESJARDINS, Seismograph Service Corporation, secretary-treasurer; CONSTANCE LEATHEROCK, Tide Water Associated Oil Company, editor; JOHN L. FERGUSON, Amerada Petroleum Corporation, N. W. BASS, U. S. Geological Survey, JESS VERNON, Amerada Petroleum Corporation, and HAROLD ENLOW, University of Tulsa, were chosen members of the council.

R. E. CHANNOCK has been elected treasurer of the National Refining Company, Cleveland, Ohio, it has been announced by K. R. PRODUCTOR, president. Channock has been assistant treasurer for the last two years.

ARNOLD D. BENNISON, employed by the General Petroleum Corporation of California since 1919, has been promoted to manager of the oil supply and exchange department of the company.

H. D. DICKSON, division civil engineer for Humble Oil and Refining Company, has been transferred from Midland, Texas, to Houston.

DON MILLER, Phillips Petroleum Company, Bartlesville, Oklahoma, has been elected chairman of the Central Oklahoma Chapter of the American Petroleum Institute. WESLEY MOORE, British American Oil Producing Company, BUD HARDER, Cities Service Oil Company, and ED STEWART, Ohio Oil Company, were named vice-chairmen. R. F. SCHOOLING, British American Oil Producing Company, is secretary-treasurer.

R. S. SHIRKLIFF, engineer with the Standard Oil Development Company, has been transferred from Elizabeth, New Jersey, to Robinson, Illinois.

L. O. WARD, superintendent at Abilene, Texas, for M. J. Delaney Company, is now at Tyler, Texas.

CAPTAIN M. T. HALBOUTY, Houston, Texas, having recently completed his training at the Fort Benning, Georgia, tactical school, has been assigned by the Army Air Corps to Wichita Falls, Texas.

ROBERT MCGREGOR, Talara, Peru, staff member of the International Petroleum Company, recently underwent a serious operation in a New York City hospital, having been flown there from Peru in an emergency airplane. He is reported improving rapidly.

ERNEST J. SNEED, assistant production foreman at Eastland, Texas, for the Lone Star Gas Company, has been made production foreman to succeed HERMAN C. KELLEY. GEORGE E. GROSECLOSE has taken over Sneed's former duties.

HARVEY E. HOOK, chemist at the Wilmington, California, refinery of Shell Oil Company, Inc., has been promoted to junior technologist in the technical department of the refinery.

A. M. SCHAIBLE, engineer, Gulf Oil Corporation, is now making his headquarters at Port Arthur, Texas. He has been at Fairview, Kansas.

J. P. MANSFIELD, Oil City, Pennsylvania, foreman in the Strong field for United Natural Gas Company, has retired after completing 45 years' service with the company.

C. S. DICKENS, Corsicana, Texas, engineer for Magnolia Petroleum Company, has been transferred to Ardmore, Oklahoma.

PAUL FAHLE, formerly geologist with the Pilgrim Exploration Company, Houston, Texas, is now a geologist with the Pure Oil Company. He is making his headquarters at New Orleans, Louisiana.

JAMES W. FERGUSON, JR., for the last three years a special representative of The B. F. Goodrich Company in Washington, D. C., has resigned to enter the United States Navy, it is announced by G. E. Brunner, general manager of the B. F. Goodrich national sales and service division. G. A. FRIEDERICI, Goodrich sales engineer in Washington since 1941, also has joined the United States Navy. G. G. ZIMMERMAN, with Goodrich in various sales capacities since 1924, has been transferred to Washington from Miami, Florida. G. R. EMPSON, with the company for 12 years and until recently sales supervisor of the company's Washington district, is now a member of Brunner's Washington organization. F. T. MARSHALL, who joined B. F. Goodrich in 1919 after graduating from Harvard, is now in charge of the Baltimore, Maryland, office of the B. F. Goodrich national sales and service division.

OSCAR HILL TRUE, 64, Shreveport, Louisiana, of United Gas Pipe Line Company's property tax department, died May 28 of coronary thrombosis. True went to Shreveport two years ago when United's offices were transferred from Houston. He had been head of the property tax department since 1931, having begun his career with the company in 1929 at Houston.

LIEUTENANT LEE M. WHETSTONE of Plymouth Meeting, Pennsylvania, formerly general superintendent of maintenance of the Automotive Transportation Department of The Atlantic Refining Company at Philadelphia, Pennsylvania, has been awarded the Victory Medal for distinguished service. The award was conferred by the Chief of the Bureau of Navigation, Navy Department. Lieutenant Whetstone is stationed at the Cape May Naval Base, New Jersey.

J. C. POLLARD resigned his position as assistant director of geophysics of Magnolia Petroleum Company, effective May 25, and hereafter will be associated with Robert H. Ray, Inc., and Rogers-Ray, Inc., in geophysical contracting and consulting work with headquarters in the Gulf Building, Houston, Texas. PAUL E. NASH, who has been with the Geological and Geophysical Department of Vacuum and Magnolia since 1926, becomes assistant director of geophysics of Magnolia.

# That Keeps Oil Coming On War Time Schedules!

To every giant bomber... to every mammoth tank... to every battleship that dives and rolls toward the enemy... gasoline and oil mean life blood. Vital fluid this petroleum. That's why it is important to keep it coming on war time schedules. Our commanders ...our sons... and our neighbors' sons... are depending on it to back them up. We won't let them down.

We can't let them down for a moment. We of the Utility Electric Power companies are striving to do our part in every way possible. And you can bet your bottom dollar we'll work shoulder to shoulder with you and all other Americans until final VICTORY is won!

PROFIT!
Utility
ELECTRIC POWER

## Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

Box 1498, Oklahoma City, Oklahoma

# LAUGH WITH BARNEY

It takes an income of six figures to get a man in the rotogravure section, but one figure will get a girl there.

* * *

How's Collins?

Flat on his back.

Why, only last night I saw him dancing with a blonde.

So did his wife.

* * *

At her request you gave up drinking?

Yes.

And you stopped smoking for the same reason?

I did.

And it was for her you gave up dancing, card parties, and billiards?

Absolutely.

Then why didn't you marry her?

Well, after all this reforming I realized I could do better.

* * *

What a party it had been! Thompson's wife was away and he'd gathered a crowd of the boys to "celebrate." Just on midnight he saw one of his guests put on his hat and walk unsteadily toward the front door.

"Ai, ol' man," he protested, "you're not goin' home yet, are you?"

"No," said the other steadying himself with one hand on the knob. "I-I'm jush goin' to mish the lasht train. Be back in a minute."

* * *

### New Inquiry

*Motorist:* How far to the next town?

*Native:* About three miles in a bee line.

*Motorist:* Well, how far is it if you have to walk and roll a flat tire along?

* * *

A newly-inducted private wrote his family some few days after he had arrived at camp:

"I've gained 60 pounds since I came here—two pounds of flesh and 58 pounds of equipment."

* * *

On going into the cowshed, the farmer was surprised to find his new hand, a town girl, giving one of the cows a drink from her milking pail.

"What are ye doin' that fer?" he demanded.

"Well," explained the girl, "the milk seemed pretty thin to me so I thought I'd put it through the process again."

* * *

The worst thing about winter nights is, if your feet finally do get warm, you've overslept.

*Employer* (to newly hired steno): Now, I hope you thoroughly understand the importance of punctuation?

*Steno:* Oh, yes, indeed. I always get to work on time.

* * *

The social worker was talking to a girl in a slum district and said: "Where is your father?" "Oh, Pap's in the penitentiary," the girl replied. "What about your mother?" "She's out here in an insane asylum," answered the girl. "And your sister?" "She's been in the Reform School a couple of years." "Well, that just leaves you and your brother. Where is he?" "He's at Harvard." "What, you mean your brother is in college? What's he studying?" "Oh, he ain't studying nothing. They're studying him."

* * *

The tourist had stopped to change tires. "I suppose," he remarked to a native onlooker, "that in these isolated parts the necessities of life come pretty high."

"Y'er right, stranger," replied the native, gloomily, "an' it ain't worth drinkin', when ye git it!"

* * *

"What are seasoned troops?" asked the bright young thing on her first visit to an army camp. To which the new recruit replied: "Oh, they are mustered by the sergeant and peppered by the enemy."

* * *

Sign on a pin-ball machine in a Birmingham cafe:

"In case of an air raid, crawl under this machine—it's never been hit."

* * *

"How long have you been working for the firm?"

"Ever since the boss threatened to fire me."

* * *

*Motorist:* I've had this car a whole year and haven't paid a cent for repairs or upkeep since I bought it.

*Friend:* So the man at the service station was telling me.

* * *

*Mistress:* This food tastes terrible. Did you salt it?

*New Cook:* Yes'm, but I never used that brand before. It was called Epsom Salts."

* * *

Gather ye rosebuds while ye may,
For Time brings only sorrow.
Girls you might have kissed today
May wear gas masks tomorrow.

It was a hot, blistering day in midsummer. Tired and dusty during a long march across the rolling prairie, the soldiers of the regiment wanted only one thing—water.

A rancher rode by.

"Say, friend," called one of the men, "how far to the next town?"

"Oh, a matter of two miles or so, I reckon," replied the rancher.

An hour passed and another rancher rode by.

"How far to the next town?" asked the men eagerly.

"A good two miles," was the laconic reply.

A weary half hour later a third rancher rode by.

"Hey, how far's the next town?," chorused the men in unison.

"Just a piece down the road—about two miles, I'd say."

The Sergeant sighed, and then he brightened optimistically.

"Well, men, we're not gaining on it, but at least we're holding our own."

* * *

*Supply Sarge:* Well, son, there's a shirt that fits like a glove.

*Draftee:* Uh-huh—now I know why the sleeves cover my hands.

* * *

"You, over there, go below and break up that crap game," called the Captain to a Sergeant.

The Sergeant was gone more than an hour.

When he finally returned the Captain roared, "Well, did you break up that game? And what in thunder kept you so long?"

"Yes, sir. You see, sir, I only had two bits to start with!"

* * *

"What put George in the hospital? Was it liquor and women?"

"Yes, he spent two months on a desert island without them."

* * *

A ship's gunner, home on leave, was sitting with his cat by the fire. His wife had to go and visit some relations, and warned him to keep an eye on the fire.

She went out. The gunner fell asleep. Two hours passed. The fire died. The wife returned. She took one look at her husband snoring before the dead fire, and screamed:—

"Fire!"

The husband leapt to attention, tore open the door of the oven, rammed in the cat, slammed the door, and cried:—

"Number One gun ready!"

* * *

*Private:* I'd like to get leave, Sir.

*Captain:* What for?

*Private:* Well, you see I'm getting married, Sir, and I'd like to be there!

BAKER OIL TOOLS, INC.

*Main Office and Factory:*
6000 So. Boyle Ave., Box 127, Vernon Station, Los Angeles, Calif.
*Central Division Office and Factory:*
6023 Navigation Blvd., Box 3048, Houston, Texas
*Export Sales Office:*
19 Rector Street, New York, N. Y.

General Heading: BAKER MODEL "B" CASING CENTRALIZER

Unit No. A-13

Subject: How Casing Centralizers Can Assist in Securing Successful "First-Time" Cement Jobs

Index: 250.1
Date: June, 1942
Page: 1 of 1 p.

Under present-day conditions, to avoid unnecessary waste of time and materials, it is essential in cementing casing that successful results be secured the *first time.*

There are, of course, many factors which influence the securing of a successful first-time cement job, one of the most important being the provision of a uniform annulus for the slurry at the critical cementing point.

Field results have indicated that the use of Baker Model "B" Casing Centralizers constitutes a particularly efficient, low-cost method of centering casing string, permitting opportunity for more complete encasement of the pipe with a uniform body of cement and reducing the hazard of channeling to a minimum.

As evidence of the effectiveness of the Baker Model "B" Casing Centralizer, below is reproduced ***verbatim*** an abstract from a field report made by a Baker representative on a job performed recently in the Griffin, Indiana, area. (Details of this job are illustrated in Fig. 1.)

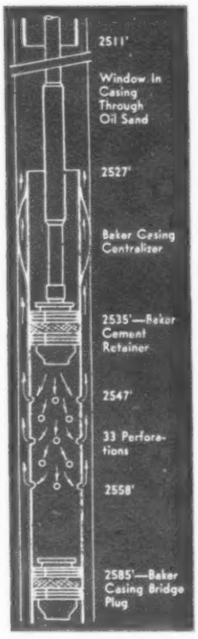



*Fig. 1*
*Arrows indicate direction of fluid.*

***"When this casing string was run, one of our Casing Centralizers had been placed just below 2527'. The XXXXXX Company men that were on the job were very convincing in their feeling that it was because of this Casing Centralizer that a perfect job of squeezing was obtained. They felt that the Casing Centralizer had held the casing in the center of the hole at this vital point so that when the casing was cemented, a perfect bond of cement was obtained completely around the casing. Had this not been true, the cement would have circulated around on the squeeze job."***

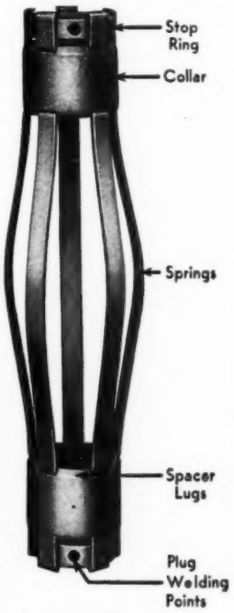
For more complete details concerning the Baker Model "B" Casing Centralizer, see pages 248-249 of the 1942 Baker or Composite Catalog.

**SERVICE NOTE: Baker Casing Centralizers are stocked by most supply stores — or are available for *immediate shipment* from conveniently located Baker warehouses.**

## CONSTRUCTION AND OPERATION HIGH-LIGHTS

Baker Casing Centralizers are simple in both design and construction and are sturdily made of materials best suited to give the unit the necessary strength for the job to be done.

An important feature of the Baker Casing Centralizer from an operating standpoint is that whether the casing is being lowered or raised, the Centralizer is always ***pulled*** through the casing or past a restriction in the open hole . . . never ***pushed.*** This pulling action eliminates any possibility of the Centralizer Springs being distorted or damaged while landing the casing.




Product No. 910

*Fig. 2*
*Baker Model "B" Casing Centralizer.*

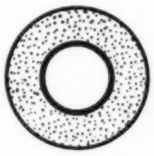


*Fig. 3*
*Note Uniform Body of Cement Around the Pipe at the Shoe Joint when Casing is Properly Centered.*

*Fig. 4*
*Note hazard of Channeling Behind Off-Centered Casing.*

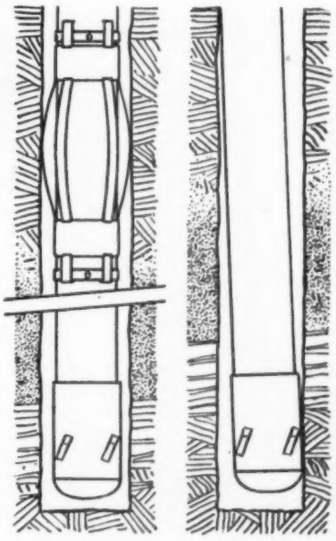


*Fig. 5 (Right) — Showing Casing at Shoe Joint Centered Through Use of Baker Casing Centralizer.*

*Fig. 6 (Extreme Right)—Showing How Off-Centered Casing Leans Against Side of Hole at Shoe Joint.*

# MACHINERY and EQUIPMENT

## Combination Tubing Hooks

A COMPLETELY new line of hooks, designed exclusively for the purpose of handling tubing, consists of BJ "75," "50," and "30" tubing hooks, each number designating the rated capacity of the hook, with a safety factor of four based upon the ultimate strength of the material.

Both the 50-ton and 75-ton hooks are of the "combination" design. The 30-ton hook is made with a single

hook body and is provided with a swivel lock. It is not equipped with relief springs, a heavy-duty ball bearing being sufficient to carry the loads imposed upon it.

In both the larger hooks, by removing only the shank pin, the body can be changed readily from the single hook type to the duplex (2-hook) type. BJ Weldless Links are thus permitted to hang vertically so that the elevator is easily opened or closed, and a uniform load distribution is obtained. The two larger hooks are equipped with an enclosed, low-stressed relief spring, having a 5-in. travel, which is strong enough to lift a stand of tubing clear of the collar, thus preventing damage to threads and speeding operations.

For work-over or perforation cleaning jobs either side of the duplex hook body can be used to pick up the swivel, and the full rated capacity of the hook is present when used for such purposes. This method is not recommended for continuous drilling operations due to the lost time in operating the locking arms. A straight pull is provided (as illustrated) and the swivel bail is securely locked in safe against accidental "jumping" of the hook, with a heavy, overhanging metal section to take any upward thrust of the swivel bail.

A swivel lock to prevent rotation, and an adapter for direct connection to the block are additional features when specified. All three sizes of these new hooks are shorter in overall length than the corresponding sizes of previous types—an important feature when overhead clearance is limited in short derricks.

Address Byron Jackson Company, Los Angeles, Houston, or New York City for all details and prices.

## Bantam Quill Bearings

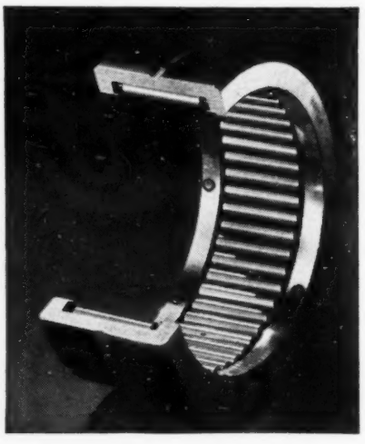
AN improved method of installing the roller retaining rings of the Bantam Quill Bearings by spot-welding not only gives a sturdier, more permanent assembly, but considerably speeds up production of this anti-friction unit, the manufacturer states.

As illustrated in the accompanying sectional view, the large number of small-diameter rollers are held in place in the outer race by retaining rings. Not only does the new spot-welding method simplify the machining operation, thus speeding assembly, but it gives a permanently placed band that will not snap loose under any ordinary conditions, it is asserted.

The illustration also shows another important design feature of this anti-friction unit: that when in service the entire load is carried to the solid outer race—none of the load, axial, or thrust is against the retaining rings that serve solely to hold the rollers in place, facilitating handling, assembly, and disassembly.

To meet the increased demand for the Quill Bearing in the country's war equipment, Bantam has also completed a program for further expanding its production capacity. High unit capacity, compact design, ease of handling and assembly, plus the simple and efficient lubrication permitted by its outer race design, are said by the manufacturer to be features that make it an anti-friction unit for front line equipment, such as tanks, trucks, and gun mounts, as well as for the machines on the production line.

Materials handling equipment, automotive assemblies, speed control equipment, many machine tool applications, and in petroleum producing machinery



are among the important fields where the Quill Bearing has demonstrated its efficiency over the period of more than four years since it was first introduced by the Bantam Bearings Corporation, South Bend, Indiana. Further information on types, sizes, ratings, and other data is given in the Bantam Quill Bearing catalog, copies of which are available on request.

## New Control for Chemical Treatment of Water

THE Graver Chemical Proportioner is a new device providing accurate control of the feed of chemicals into the water-treating plant in proportion to the volume of water. The equipment insures uniform treatment at all times regardless of volume of water entering treating plant, the manufacturer asserts. It permits instant increase or reduction of chemical charge over a wide range should water require change of treatment.

The proportioner is readily adapted to any make of solution type chemical feeder when a swing pipe or skimmer can be installed in the chemical feeder.

Write to Graver Tank and Manufacturing Company, Inc., East Chicago, Indiana, for Bulletin 310 describing this equipment.

## MOLYBDENUM ENLISTS FOR THE DURATION

The enormous increase in requirements of molybdenum has necessitated the War Production Board Order M-110, placing molybdenum consumption under allocation control...Our metallurgical research staff is fully engaged in war work. At our mine, mill and converting plant, every effort is being made towards maximum production.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

**Climax Molybdenum Company**
**500 Fifth Avenue • New York City**

**MOLY**

## Heavy-Duty Non-Skid Clamp; All-Steel Drill Press Vise

A C clamp with features that prevent skidding when tightening has been designed by Patterson-Ballagh Corporation. The clamp tip is equipped

with a bronze bushing in which the end of the screw rotates. The screw is made of heat-treated steel. This bushing prevents galling and provides a free movement so that slippage on the work is prevented. The frame is made of cast steel, also made with terminal lug for use on grounding cable during arc-welding. A welded T-shaped wrench handle allows a firm grip.

A simple inexpensive and practical all-steel drill press vise to meet all shop conditions is also announced by the company. In all three working positions it lies flat on the face plate. A square thread operates against a bronze thrust bushing. The use of two guide bars permits the operator to drill completely through the work without injury to the vise, thereby speeding production. The equipment is said to be admirably adapted to small assembly work and to hold small pieces for machinery, filing, etc., during bench operations. The vise is made in two sizes; the one illustrated is 5½-in. opening, with ears to fasten to the face plate. It is made also with 3-in. opening, without ears, otherwise of the same sturdy construction.

Further details can be obtained from Patterson-Ballagh Corporation, 1900 East 65th Street, Los Angeles, California.

## Well-Logging Service for South America

SEISMOGRAPH Service Corporation of Tulsa, Oklahoma, has announced the availability in Venezuela of a drilling mud analysis unit.

Charles B. Johnson, development engineer, formerly associated with John T. Hayward of Barnsdall Research Corporation, will be in charge of well-logging in South America for the company.

This method of logging is based on the principle that fluid gases in the drilling mud, it is stated. The recorder also automatically records the drilling rate in feet per hour, the actual points of weight applied on the bit, and the speed of the rig slush pump in strokes per min.

It is asserted that the benefit derived from this logging method is the continuous logging of the well during drilling, without materially retarding drilling progress, which gives information regarding the fluid contents of

pore spaces of the cylindrical core drilled-up by the bit are picked-up and transported to the surface by the circulating drilling mud. If, then, instruments capable of detecting these substances are provided with a means of determining their depth of origin, the well may be logged as drilling progresses.

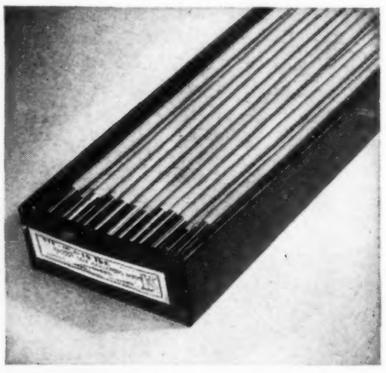
The logging unit illustrated contains instruments capable of detecting and automatically recording the presence and nature of gases and fluids in the porous formations, their depth below the surface, relative productivity, apparent porosity, thickness, and hardness. These data combine to give a complete picture from which may be derived correct subsurface correlations, and the necessary information to complete the well in order to produce the maximum volume of oil.

The mud-logging equipment for this service is manufactured by Engineering Laboratories, Inc., Tulsa, Oklahoma.

## Hard-Facing Rods

TO SERVE companies not having high priority ratings, the Stoody Company has developed two new hard-facing alloys that are being marketed under the trade names of Stoodite K and Stoody Self-Hardening K.

Stoodite K is a cast hard-facing rod consisting principally of molybdenum,



tungsten, manganese, silicon, carbon, and iron. It is supplied both in bare form for oxy-acetylene application and in coated form for d-c. electrical application. It is available in five rod sizes: ⅛ in, $\frac{3}{16}$ in., ¼ in., $\frac{5}{16}$ in., and ⅜ in., and in rod lengths of 14 in. Deposits of Stoodite K average 54-58 on the Rockwell C scale, depending on the type of parent metal and the method of application. Stoodite K forms smooth, dense deposits free from porosity and shrinkage cracks, the manufacturer states. These deposits will withstand considerable pressure and impact if properly supported, and they offer excellent resistance to all types of abrasive wear, it is asserted.

Stoody Self-Hardening K is composed principally of molybdenum, manganese, silicon, carbon, vanadium, and iron, and is made in the form of tubes with the mixed alloys on the inside. This rod is supplied bare for oxy-acetylene application and bare and coated for d-c. electrical application. It is available in three rod sizes: ⅛ in.,

$\frac{3}{16}$ in., and ¼ in. Electric rods are 14 in. in length; acetylene rods 28 in.

Deposits of Stoody Self-Hardening K average 50-54 on the Rockwell C scale depending on the type of parent metal and the method of application. In addition to being highly resistant to wear, Stoody Self-Hardening K also will withstand considerable impact if properly supported, it is asserted. It forms an excellent bond with manganese steel and can be used for hard-facing various types of manganese equipment. Deposits can be forged providing forging is done at red heat.

Both Stoodite K and Stoody Self-Hardening K are available under the regular A-10, P-100 rating. Folders showing prices and specifications of the new rods may be obtained by writing to Air Reduction Sales Company at 60 East 42 Street, New York, New York.

## Conductive Belting Ends Static Hazard

"CONDUCTIVE" rubber belting that will end static caused by friction, dangerous in the oil industry, is announced by the United States Rubber Company, New York, New York.

The product was made possible by a discovery that turned rubber, originally an insulator, into a conductor. Thus in a product made from this substance static electricity that accumulates is harmlessly carried off.

Because of the low resistance of the material, however, there is no danger of an electrical connection from one transmission line to another should an accidental short circuit occur.

The conductivity feature is especially desirable in hazardous areas and also in handling material that carries electrostatic charges. Such material as paper, cellophane, and explosive powders are not attracted to a conductive belt. The trade name Uskon will be used.

Transmission belts are the friction surface envelope type. They have been subjected to severe tests at speeds from 100 to 4000 ft. per min. with the humidity as low as 16 percent. When the resistance of the belts ran as high as 100 megohms, measured between two electrodes 1 in. apart, the belts showed no static on a sensitive gold leaf electroscope.

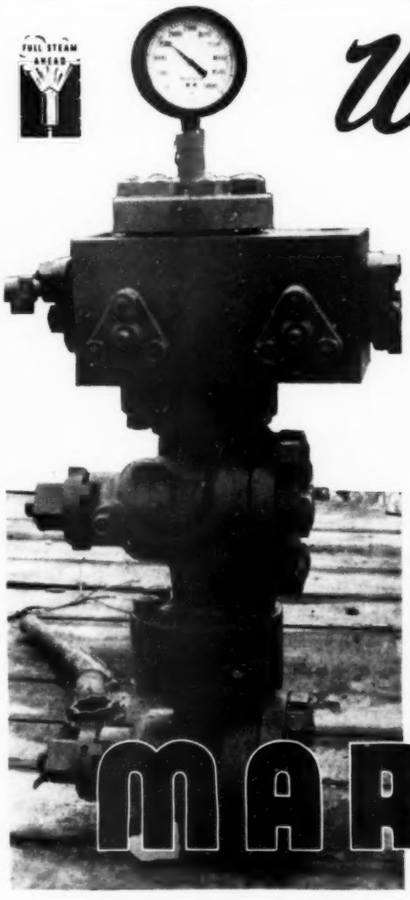
Two types of conveyor belts are supplied, one with a 2500 to 3000 lb. long wear conductive cover, and the other with a 1000 lb. cover for less severe service.

The United States Rubber Company is inviting inquiries covering special applications of the new product.

## Cement Dump

A NEW Cement Dump with several unusual features has been developed by Shull Perforating Company. The ground seat and ball dump valve provide positive closure as the Dump is lowered into the well. Pressure in the well increases the tightness of the seat and prevents dilution and cement losses that so often occur, according to the manufacturer. Another feature is the automatic tripping mechanism, which opens the dump valve simply by the upward movement of the sand line. This puts the Dump under complete control of the operator at all times and permits the placing of cement or chemical in the well casing exactly where it is wanted, without dilution or loss, according to the manufacturer. Jerks on the line due to faulty spooling can not trip the Dump release. With the tripper release operated from above rather than by hitting bottom, much time is saved on cement jobs, as repeated trips can be made without having to wait for hardening.

This device, named the Dempsey Cement Dump, is machined from alloy steel to resist strains resulting from high-speed operation. Sizes range from 1½ in. to 4½ in. A bulletin may be obtained from Shull Perforating Company, Long Beach, California.

War Worker—

THAT describes not only every man in the petroleum industry today, but every piece of equipment too. Each device plays its small but vital role, and none is tougher than the part played by gauges.

Recognition of this is evidenced by the large and ever-growing number of Marsh Mastergauges that are performing their tasks so supremely well throughout the industry. In this remarkable instrument you have one more proof of the ability of American industry to find a better way.

Its precision-built movement and its bourdon tube turned from solid bar stock give new meaning to accuracy and stamina. It also offers the "Recalibrator"—the first basically sound way of quickly re-establishing the accuracy of a gauge when it is knocked out of adjustment.

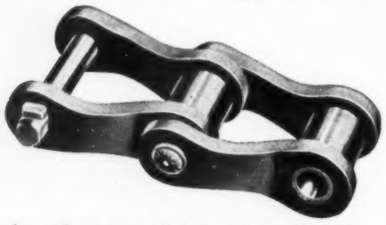
Your Supply House can give you the facts about Marsh Gauges, Dial Thermometers and Recorders for every service.

JAS. P. MARSH CORPORATION
2097 Southport Ave., Chicago, Ill.

MARSH GAUGES

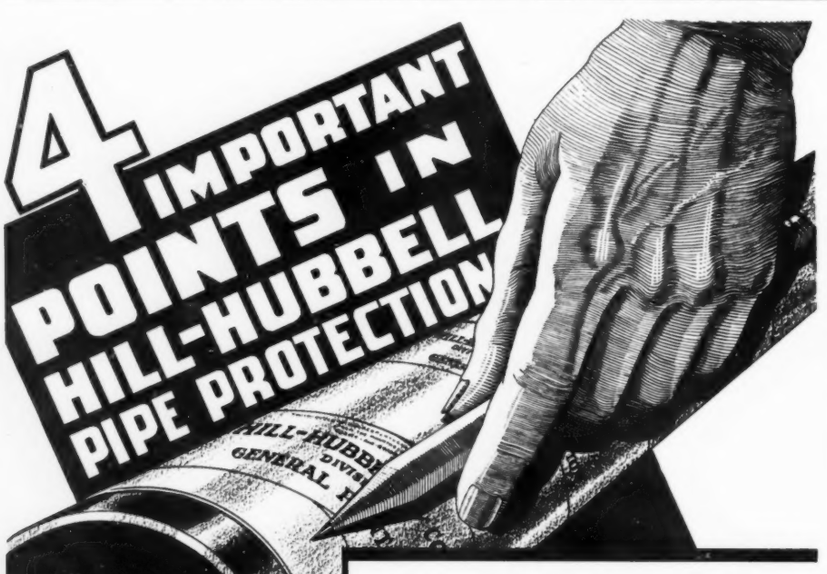
### Chain Belt Development

CHAIN BELT COMPANY, Milwaukee, Wisconsin, has announced a new riveted type chain belt



that, because of its universal design, is said by the manufacturer to offer the maximum in service, economy, and long life. It has all the features previously found in the cottered Rex oilfield chain belt but overcomes one of the major objections to the cottered type, which is that occasionally the cotters work loose and obstructions to the motion of the drive will sometimes shear them off. Obviously, shorter working life and higher chain costs result. The Rex riveted chain belt overcomes this fault and still retains the advantage of the cottered chain, which is ease of disassembly and assembly in the field, according to the makers.

The accompanying illustration shows a two-link sample of Rex Deepwell A.P.I. 4, showing the new riveted design. This new riveted chain belt is also made in the other Deepwell size: A.P.I. 3, and Champion A.P.I. 3 and 4.


1 STEEL PIPE thoroughly cleaned, is primed by mechanical rotary brushes.

2 MULTIPLE COATING-AND-WRAPPING applied by modern machine method.

3 HILL-HUBBELL processed pipe is FACTORY inspected and approved before shipment.

4 ECONOMICAL—costs no more to install and gives better pipe protection.

*Write today for detailed information contained in "THE BOOK OF PIPE PROTECTION"*

HILL-HUBBELL Coated-and-Wrapped pipe is produced at these leading mills . . .

JONES AND LAUGHLIN STEEL CORPORATION

NATIONAL TUBE CO.

REPUBLIC STEEL CORPORATION

SPANG CHALFANT, INC.

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE: SAN FRANCISCO, CALIFORNIA, U. S. A. •


### Taylor Fulscope Time Schedule Controller

MAINTAINING exact temperature, pressure, flow, or liquid level according to a predetermined time schedule is the duty of the new Taylor Fulscope Time Schedule Controller. After the ideal processing schedule has once been determined, it is possible with this new Taylor instrument to automatically and precisely repeat the process as many times as desirable, the manufacturer states.

The cam and the chart are individually mounted and conveniently placed for instant visual comparison on this latest development of the Taylor Instrument Companies, Rochester, New York. So completely new, and incorporated with the Fulscope Controller, the Taylor Fulscope Time Schedule Controller is said to present many improved features, among them friction drive cam assembly that permits rotation of the cam without loosening any locking means; improved means of resetting one cam without disturbing the other in an instrument with two complete control mechanisms; each cam capable of operating from one to four air valves, micro-switches or both for the actuation of any external mechanism such as a valve, bell or light, and do this automatically in any desired relationship of one to the other, and the automatic return of the cam to the starting position.

An optional feature of this new Time Schedule Controller is the Interrupter Timer, which allows extreme flexibility to both the rise and the holding periods of the process under control. This timing feature allows the use of a very fast cam clock for a rapid rising period, but reduces the speed of the clock to increase the length of the holding period. The rising period, the holding period, or both, may be increased as much as 6½ times normal period with this new Taylor Interrupter Timer. It is built right in the Time Schedule Controller, eliminating the need for a separate timing controller.

The new Taylor Time Schedule Controller is available in all control forms,

including automatic reset and Pre-Act. By the addition of pre-calibrated assemblies it can easily be converted to fit any process requirements that might arise in the future, the makers state. Universal case for face or flush mounting is provided.

Detailed information is available on request; ask for Bulletin No. 99111.

## Substitutes for Tin-Base Babbits

TWO new lead-base bearing metals, known as Pyramid and Defender, have been developed by the Magnolia Metal Company, 120 Bayway, Elizabeth, New Jersey, as substitutes for tin-base babbitts that are now so difficut to obtain.

Pyramid Metal is well suited to applications where bearings must withstand heavy sustained pressures, such as are found in marine reciprocating engines, water turbines, paper mill calendar stacks, and rolling mill machinery, the manufacturer asserts.

Defender Metal stands shocks without cracking and is well suited for use in internal-combustion engines, trap rock crushers, and sifter machinery, it is asserted.

For steady high speeds and uniform loads such as are found in line shafting, electric motors of 10 to 250 hp., pumps and general machinery, the makers recommend Magnolia Anti-Friction Metal.

Further details on all Magnolia bearing metals will be sent on request. Write to Magnolia Metal Company, 120 Bayway, Elizabeth, New Jersey.

## Spray Treats Burns

QUICK, painless application of burn treatment is now available by merely pressing the valve on a dispenser bottle, which liberates a fine, steady spray of tannic acid to cover the burned areas. The tannic acid is fully prepared, needs no mixing prior to application, and is ready for instant use.

This unit is one of the features of the new Bullard Emergency Burn Kit. Besides the tannic dispenser bottle, the Bullard Kit contains castor oil for eye burns and a complete assortment of treatments and dressings. The units are packed in an attractive wooden case, natural finish, that is easy to open and that offers complete dust-proof protection to the dressings.

With industrial activity at its all-time peak, and with so many briefly trained men and women at work, this effective emergency kit for burn treatment protects workers from unnecessary pain and scarring from industrial burns and promotes rapid healing, it is stated by the manufacturer, E. D. Bullard Company, San Francisco, Calif.

## Haering Corrosion Inhibitor

THE D. W. Haering and Company, Inc., research laboratories in Chicago, announce development of a new corrosion inhibitor identified as ferri chrom glucosate. This new inhibitor is the ferric salt of quachrom glucosate and introduces a non-oxidizing chromium inhibitor for the first time. Ferri chrom glucosate controls corrosion in some applications in concentrations as low as two parts per million and may be employed in reducing equilibria and at low pH values for corrosion control, it is stated.

Ferri chrom glucosate is a colloidal gel, which may be used for film formation in process operations by dipping or spraying or may be incorporated in paints or lubricants for corrosion control.

Ferri chrom glucosate contains very little chromium and is non-irritating to handle. Its use for corrosion applications may reduce chromium consumption for this purpose as much as two decimals at the same time providing more effective control, it is stated.

Write D. W. Haering and Company, Inc., 205 West Wacker Drive, Chicago, Illinois.

**Save Time by Using COLMONOY Hard Surfacing Alloys**

You can save time, increase production and cut costs by coating all parts subject to excessive corrosion and abrasion with COLMONOY—pump sleeves, wash pipes, plungers, rings and many other parts of oil producing equipment.

One large oil company ran comparative tests, pumping hot oil at 900° and pump running at 3600 R.P.M. The COLMONOY coated pump sleeves ran for 2400 hours, against 360 hours for other sleeves.

The head of a welding company recently wrote our engineering department. He had never used COLMONOY — and wanted full information as to the proper grades to use, prices and methods of application.

Part of his letter read as follows:

*We have a particular problem presented by the packing sleeve of a hot oil pump in a nearby refinery. The last sleeve was faced with* COLMONOY *and lasted three to four times as long as the original faced sleeve. We have been asked to bid on a set of sleeves faced with* COLMONOY *No. 6.*

COLMONOY will keep new parts on the job longer—and many worn out, discarded parts, when COLMONOY coated, will outwear and outperform new, uncoated parts many times over.

*Write Today for Full Information*

**WALL-COLMONOY CORP.**

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NEW YORK CITY, BLASDELL, N. Y.; CHICAGO; TULSA; WHITTIER, CALIF.

*Other branches in Canada*

**COLMONOY**

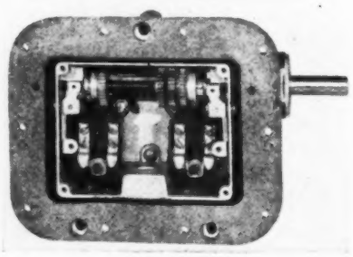
Hard Surfacing Alloys and Overlay Metals

## GE Rotating-Type Limit Switches

THE General Electric Company, Schenectady, New York, has announced the addition of two new forms to its line of CR9441-C2 rotating-type limit switches. One form is for Class 1, Group D, hazardous gas locations, and the other is for applications requiring a water-tight switch. The new switches are both housed in heavy, flanged, cast-iron enclosures.

The mechanism of the switch is adjusted to operate the contacts between a minimum of one-half turn of the driving shaft and a maximum of 120 turns. Indefinite overtravel will not harm the switch mechanism.

Double-break, fine-silver contacts clean themselves by opening and closing with a rocking motion. New contact tips can be installed with a screwdriver.



One double-break contact is at each end of the travel, and can be made normally closed or normally opened without additional parts. A large (¾-in.) conduit entrance and roomy box make for rapid and easy wiring.

Conserve Vital War Materials with GRIZZLY
The Grizzly Patented Pressure Seal Coupling that provides a positive seal, preventing leaks and blowouts, or damage to hose by squeezing or pinching. Full-flow throughout entire length of hose and coupling. (Patent No. 2,151,307.)
A 50-ft. length of Grizzly Powerflex 3" Rotary Hose, illustrating exceptional flexibility without strain or kinks at any point.
PRESSURE SEAL
3" GRIZZLY POWERFLEX

Rotary hose is essential to drilling oil wells . . . and both rubber and oil are essential to war. It is important, therefore, to use rotary hose that will give the longest and most satisfactory *trouble-free* service.

Every length of Grizzly Powerflex Pressure Seal Rotary Hose bears a serial number and is supplied with a standard form for maintaining a record of service. These service records provide indisputable proof of the length and character of Grizzly performance under the most severe drilling conditions.

To conserve vital materials, equip your wells with Grizzly Hose and maintain careful records of service on all wells. Ask your supply dealer or any Grizzly representative for complete information.

**GRIZZLY MANUFACTURING CO.**

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Complete Stocks Maintained in Our Warehouses At:
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*Distributed by Leading Supply Companies.*

**GRIZZLY**
REG. U. S. PAT. OFF.
**PRESSURE-SEAL ROTARY HOSE**


## Tag Self-Operating Controllers

THE C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York, announces a new line of temperature controllers. These instruments are entirely self-contained and self-operating.

The Tag Self-Operating Controller uses no power other than the energy developed in its own system. The temperature changes at the sensitive element or bulb in the apparatus under regulation, raises or lowers the vapor pressure of the volatile liquid in the tube system. A capillary connecting tube transmits the pressure change to the power bellows. The bellows expand and contract in response to the temperature changes at the bulb, position the steam valve, and so control the temperature.

The Tag Self-Operating Controller is described in a new catalog No. 900E. A free copy will be sent by the manufacturer on request.

## Small Turret Lathe

A NEW bench model turret lathe for rapid production to close tolerances on chucking operations or bar work has been announced by the South Bend Lathe Works. This lathe has a 10-in. swing over the bed and saddle wings, 1⅜-in. hole through the headstock spindle, and 1-in. collet capacity. It is well adapted to second operation work, the manufacturer states.

A large assortment of attachments and accessories simplify tooling for specialized work or second operation jobs. For information, write to South Bend Lathe Works, Department P7, South Bend, Indiana.

## In Charge Fort Worth Office Franks Mfg. Co.

Clair C. Simmons, who took over his first "real job" with Franks Manufacturing Corporation more than 8 years ago, has been placed in charge of the Fort Worth, Texas, branch office of the company to succeed R. N. White, who has been called to Washington temporarily.

C. C. SIMMONS

Simmons went to work for Franks in January, 1934, doing shop work and operating a drill press. In 1936, he began two years as a service man, and in 1938 he began his experience as a roughneck, working for the Shell Oil Company at Big Spring, Texas.

On January 1, 1940, Simmons was transferred to the Odessa, Texas, office of Franks, where he opened and operated the first branch parts warehouse and service department in Franks' history.

## Wm. A. Roever, Clark Bros., Joins Coast Artillery

William A. Roever, sales engineer since 1937 for Clark Bros. Co., Inc., compressor manufacturer, first at the Dallas and later at the Houston branch office, has recently been called to military service at Camp Wallace, Texas. Entering service as a member of A Battery, 31st Artillery Training Battalion, since April 15 he has held the rank of adjutant on the battalion staff.

WILLIAM A. ROEVER

Lieut. Roever is a graduate of Washington University, at St. Louis, Missouri, where he received a B.S. degree in mechanical engineering in 1930. While at the University he took four years of R.O.T.C. work and in 1929, before his graduation, he was commissioned a second lieutenant in the Coast Artillery Corps, Anti-aircraft. In addition to his four years of R.O.T.C. work, he has served in Coast Artillery at Fort Knox, Louisville, Kentucky, and at Fort McClean, Anniston, Alabama, attaining the rank of first lieutenant. Later still he saw artillery service with the Texas National Guard.

## T. F. Kittredge Passes Away

Theodore Franklin Kittredge, 55, Little Rock, Arkansas, died in the hospital at Little Rock on May 9, 1942. He was district manager for the Dearborn Chemical Company of Chicago, in Arkansas, Louisiana, and East Texas. He had been associated with this company since January, 1925.

He is survived by his widow, Mrs. Grace Kittredge; one son, Theodore F. Kittredge, Jr., U. S. Army; his mother, Mrs. B. F. Kittredge, Tulsa, and a brother, E. L. Kittredge, Enid, Oklahoma. Funeral services were held May 11 at Trinity Cathedral in Little Rock.


"CLEVELANDS"

Will Cut Hours Off Your Pipe Line Construction Schedules

HERE'S a machine that will save you money from the word "go"—and be just as ready to go on the second hundred miles as the day you bought it. Under every conceivable condition, whether it's tropical swamps, rocky ground, mountainous territory, abrasive sand, sticky mud, or just plain ordinary dirt, the "CLEVELAND 140" leaves nothing to be desired in the way of performance.

The "140" is a balanced combination of all the features which have been found most desirable for pipeline ditching, such as: ample power for the toughest tasks—speed and fast maneuverability—dependable, tested, full-crawler traction—wide tread and low ground pressure—multi-speed transmission—enclosed gears—double strength steel in frame, boom and ditcher-buckets—quick accessible unit type construction—box-type ditcher boom—and super quality materials throughout. You just can't miss when you pick "CLEVELANDS" for your ditching jobs, for they're built to produce and endure.

THE CLEVELAND TRENCHER COMPANY

20100 ST. CLAIR AVE. "Pioneer of the Small Trencher" CLEVELAND, OHIO

"CLEVELANDS" Save More . . . Because they Do More

## W. C. Johnson Advanced By Allis-Chalmers

Walter Geist, president of the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, announces that William C. Johnson, sales manager of the crushing and cement division, has been named manager of the Allis-Chalmers general sales organization.

Until his election as president, Geist directed the general sales organization first as general representative and later as vice-president.

As general sales manager, Johnson will direct the sales of 1600 different products and the operations of 60 district offices.

## Gustav Egloff Elected Head of Chemists

Dr. Gustav Egloff, director of research of Universal Oil Products Company, Chicago, Illinois, was elected president of the American Institute of Chemists at the annual meeting of the Institute, held at Atlantic City, May 16.

Dr. Egloff was the recipient in 1940 of the gold medal that is awarded annually by the Institute to the man adjudged to have made significant contributions to chemistry and the welfare of the chemical profession during his career.

Donald A. Price, National Oil Products Company, Harrison, New Jersey, was elected vice-president, and H. S. Neiman, patent attorney, New York City, was elected secretary.

GUSTAV EGLOFF

Dr. Egloff is now organizing a Chicago chapter of the Institute.

On the Alert
TO SERVE YOU. Under present conditions, one of the most important services a clutch manufacturer can offer industry is a competent and adequate parts and service organization to assure uninterrupted production, prevent costly delays in waiting for factory shipments of needed parts.
That's why the Twin Disc Clutch Company maintains seven strategically-located, factory-controlled branches and 30 parts and service stations, each with ample stocks of parts. Skilled service men are on call 24 hours a day, constantly "on the alert" to serve you . . . to prevent time-consuming delays due to accident or any other cause.
When in need of parts or service, call your nearest Twin Disc representative.
1. Hydraulic Torque Converter. 2. Power Take-off. 3. Model E Clutch.
1
2
3
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CLUTCHES AND HYDRAULIC DRIVES
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**Alabama:** Montgomery, Parts Service Corp. **California:** Los Angeles, Charles W. Carter Co.; San Francisco, Charles W. Carter Co. **Colorado:** Denver, Liberty Trucks & Parts Co. **Florida:** Jacksonville, Motor Parts & Supply Co. **Illinois:** Chicago, Wisconsin Industrial Parts. **Kansas,** Great Bend, Scheufler Supply Co. **Kentucky:** Lexington, Wombwell Auto Parts Co. **Louisiana:** New Orleans, Mechanical Equipment Co. **Maine:** Portland, Southworth Machine Co. **Massachusetts:** Boston, Rapp Hurkins Co., Inc. **Michigan:** Detroit, W. C. DuComb Co., Inc. **Minnesota:** St. Paul, Trucks Parts, Inc. **Missouri:** St. Louis, Twin Disc Clutch Co. **New York:** Buffalo, Edward W. Rode; New York City, Twin Disc Clutch Parts & Service of New York, Inc. **Ohio:** Cincinnati, C. McCash; Cleveland, Twin Disc Clutch Co.; Industrial Eng. Parts. **Oklahoma:** Tulsa, Twin Disc Clutch Co. **Pennsylvania:** Pittsburgh, Contractors Equip. Ser. Co.; Philadelphia, Twin Disc Clutch Parts & Service of Philadelphia. **Tennessee:** Knoxville, Automotive Equip. & Supply Co.; Memphis, Choctaw Culvert & Mchy. Co. **Texas:** Dallas, Twin Disc Clutch Co.; Fort Worth, Jno. Muller Co.; Houston, Portable Rig Co., Inc.; Jno. Muller Co. **Utah:** Salt Lake City, Lund Machinery Co. **Virginia:** Richmond, Standard Parts Corp. **Washington:** Seattle, Twin Disc Clutch Co. **Canada:** Montreal and Toronto, Consolidated Engines and Machinery.

**TWIN DISC CLUTCH COMPANY • 1329 RACINE STREET • RACINE, WISCONSIN**


## R. A. Feemster Division Sales Manager for Kobe

R. A. Feemster, formerly special sales representative for Kobe, Incorporated, was appointed Mid-Continent Division sales manager. He will continue to make his headquarters in the company's division offices at Oklahoma City, Oklahoma.

R. A. FEEMSTER

Feemster was graduated from Oklahoma University's School of Petroleum Engineering in 1932, after which he was associated with Phillips Petroleum Company for several years in the engineering and production departments. After leaving Phillips, Feemster was variously associated with oil-field equipment companies doing creative work in drilling and completion projects.

## New Kobe Appointments

C. M. Rader, general sales manager of Kobe, Incorporated, has announced the appointment of J. J. Siegel as sales manager in charge of slotted pipe and prepack gravel liner sales, and W. F. Slater as California district manager.

J. J. SIEGEL

Both men will make their headquarters at Huntington Park, California.

Siegel will be in charge of the company's sales of screen casing and gravel-packed liner both in foreign and domestic markets, and brings to his new position widespread experience in oil-well screening problems. He was associated with the early pioneering of

W. F. SLATER

oxygen and acetylene welding and cutting apparatus on the Pacific Coast with such companies as the California Burdett Oxygen Company and later the California Compressed Gas Company. Upon the organization of Kobe, Incorporated, Siegel became associated with the company's first efforts in developing slotted pipe and has been continuously interested in this work since that time.

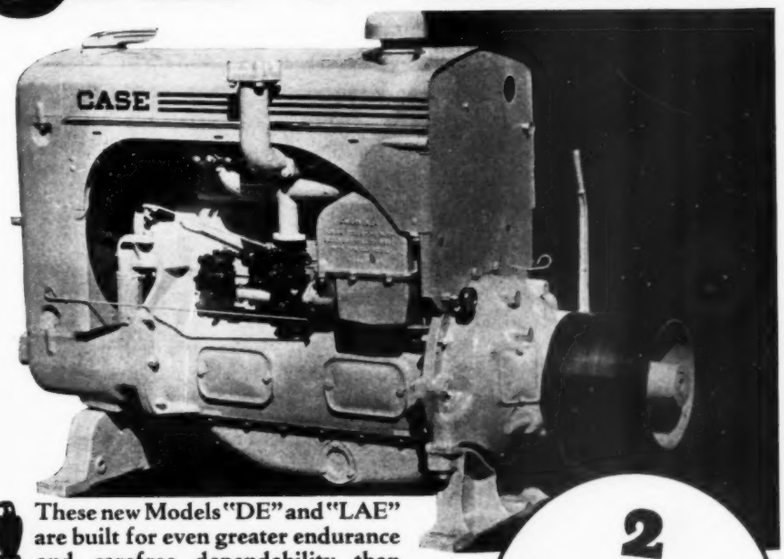
Slater attended the engineering schools of Oklahoma University and Tulsa University, and was for several years actively engaged in oil production problems in the Mid-Continent area. In 1936 he became interested in engineering studies of pumping equipment problems in both the Mid-Continent and California oil fields; and, in 1941, joined Kobe, Incorporated, as Tulsa district representative, which position he has filled until his recent appointment as California district manager.

## Arkansas Commission Opens Technical Office

A new technical office was opened in Magnolia, Arkansas, by the Arkansas Oil and Gas Commission June 1. All reservoir testing equipment, consisting of three completely equipped bottom-hole pressure trailers, together with subsurface gauges and calibrating equipment, has been moved from El Dorado to Magnolia. Portable gas meters used in determining operating gas-oil ratios, equipment for the testing of natural gas for its gasoline content, specific gravity, and hydrogen sulphide content are also included in the equipment moved to Magnolia. The office is situated near the quarters of the McKamie Gas Cleaning Company on land leased by the state.


*Pumping Power*

**STEPS AHEAD**




**2 Brand-New Models**

**These new Models "DE" and "LAE" are built for even greater endurance and carefree dependability than prior models which made oilfield history. New radiators give greater reserve of cooling capacity for summer heat. Improved oil pump, strainer, and delivery ducts insure positive oiling under wider extremes of heat and cold. Four-ring pistons divide ring wear, defer ring replacement. Case-built, full-sealed magneto offers the utmost in dependable ignition. Case-built oil-bath air cleaner and new long-lived shaft seals guard entire engine against dust. Automatic cut-outs prevent damage if engine temperature goes up or oil pressure goes down. Get full details from your distributor.**

**J. I. Case Co., Racine, Wis.**

**DISTRIBUTORS**

**Southwest Equipment Co.**
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Tulsa, Oklahoma

**CASE**

**Oil Field Engines**

## Salvage Plans in Operation In California

At a meeting of the recently formed California Oil Industry Salvage Committee held in Los Angeles, May 27, 1942, the critical scrap situation and the important contribution that can be made to the war effort through the coöperation of the oil industry was discussed by M. R. Singleton, salvage director for the petroleum industry, Bureau of Industrial Conservation, W.P.B., Washington, D. C. Singleton stated that "The War Production Board has delegated to the Bureau of Industrial Conservation the responsibility of developing salvage programs for waste materials — iron and steel scrap, non-ferrous metals, cotton and woolen rags, paper, rubber and burlap — whenever they can be found throughout the land. In this bureau is the Industrial Salvage Section that concerns itself only with salvage and scrap from industry, as the name would imply. This section operates harizontally through what are termed industrial centers getting into channels of trade all sorts of scrap from industries in the more densely populated centers and vertically in certain industries.

"It is not necessary to deal with statistics at this time, because regardless of how much scrap has been collected, the fact remains that we too often have steel mills shut down for lack of metal scrap. In the prosecution of war successfully, there are three needs that must be met — food, oil, and steel. With all of them a war can be won, provided the people have the will to fight and win. For the lack of any one of these three, a war may be lost, even though the will to fight remains. There will be no real shortage of food, nor will there be an actual shortage of oil. The great pressing need today is steel, and a continuous shortage of scrap material to make the steel has assumed dangerous proportions.

"In ordinary times, scrap metal accounts for anywhere from 25 to 50 percent of our steel production. For example, it took 26,000,000 to 27,000,000 tons of iron and steel scrap to produce the steel tonnage turned out in 1941. Now, to produce the 100,000,000 tons needed for this year, there must be made available approximately 35,000,000 tons of scrap metal. In the operation of a steel mill, the character of the steel produced dictates the amount of scrap necessary to make that particular quality of product. It runs from the figures that I just gave up to 100 percent scrap charge in certain alloys.

"The scrap situation in California is this: Today the mills and foundries have 125,000 to 150,000 tons of scrap on hand. The dealers have between 15,000 and 20,000 tons in their yards. Your consumption is 101,000 tons per month just for the mills now in operation. More than this will be necessary when additional facilities are built. A slide rule is not necessary to know the answer.

"Let me call your attention to the fact that it takes 2000 tons of ship plate and 300 tons of structural steel to make a 10,500-ton merchant ship. Of course you know that the shipyards on the West Coast have a tremendously large program for building this type of cargo vessel. Further, every steel mill is engaged in 100 percent war work. We must make up an estimated shortage during the balance of 1942 of between five and six million tons of metal scrap. Today there are nine open hearth furnaces closed down for lack of scrap metal.

"The oil industry has been called upon many times to shoulder terrific burdens and to operate under great hazard in their divisions of production, transportation, refining, and marketing. When called upon to produce 1300 percent more gasoline with only 100 percent increase in the production of crude oil, they met that challenge successfully. When called upon to produce 100-octane gasoline for our air force, our industry was ready. When called upon to produce special lubricants for the air forces, they began immediately to deliver the grades and quantities asked for. But the oil industry was never faced with a greater challenge than it is today. The industry is asked closely to survey every physical unit and to survey oil fields, pipe lines, and refineries, proceed with the collection of scrap and with a program for demolition of all idle or obsolete units that can be reasonably dismantled and to salvage for re-use any items that can be used again and to send the scrap material to the mills through the regular channels of trade.

"In our oil fields there are old drilling rigs, steam pumps, boilers, and miscellaneous scrap of all kinds. In our refineries there are obsolete units, dormant and obsolete inventories that are potential sources of the quantities of scrap materials so greatly needed today —old manifolds, oil pumps, obsolete skimming and cracking units, old tanks.

"This committee knows the state oil situation and we can only offer suggestions, which are:

"1. That in each district a plan to insure that all waste materials, particularly metals and rubber, are removed from all locations, concentrating on a definite program for each district and setting a time limit for completion of these efforts.

"2. Encourage the review of all idle facilities, including refineries and natural gasoline plants, that are no longer in service, abandoned pipe lines and production equipment both for drilling and handling of oil, making preparations and carrying out dismantling wherever possible.

"(a) To facilitate economic action in any dismantlement, you are requested to give all assistance possible, obtaining information on what secondhand equipment and material the owner will not require after the completion of this program and see if use can be


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**Defense First!**

**Our Nation's Defense needs come first—and we take pride in the knowledge that McKissick Blocks are playing a part in the building of defense materials.**

**McKissick Blocks are also doing double duty in hundreds of oil field jobs every day. There's a McKissick Block for every purpose. Our representatives, located in all active fields, will be pleased to help you.**

**McKISSICK PRODUCTS CORP.**

Tulsa, Oklahoma

"Keep 'em Flying!"

found for this equipment in other oil companies at prices better than they can receive from dealers.

"3. Arrange for meetings in every district in the State of California, one for each month for the next four months until the close of the program and the anticipated results will be better known.

"4. Personally arrange for the contact for each salvage man in each company by members of your committee.

"5. Explain thoroughly to the entire petroleum industry how scrap should be moved to dealers and their part in the general program. Supply a partial list of the scrap firms that are operating in the districts concerned.

"6. Explain the method of reporting the movements of scrap and how this information is necessary and available to the Industrial Salvage Section.

"7. Solicit further suggestions and improvements from your fellow workers in the petroleum industry to keep this program moving.

"As you know, the petroleum industry is interested not only in furthering the war effort by the conversion of useless material to scrap, but also by enabling each company to procure a supply of the very necessary secondhand materials that are required for continuation of their operations. Remember that no scrap steel has been shipped away from the coast since the embargo in 1940. It is a necessity that we have a backlog before further withdrawals shall occur due to the increase in the number of furnaces.

"The vital factor in this situation is speed. What you are asked to do is to assume the assignment, the responsibility, and have the oil industry lead the way for all industries in California."

The California Oil Industry Salvage Committee consists of: Paul Shoup, chairman; Lloyd M. Williamson, California Star Oil Company, vice-chairman; L. L. Aubert, Bankline Oil Company; Rush M. Blodget, Oil Producers Agency; Floyd Bryant, Standard Oil Company of California; R. M. Burk, National Supply Company; L. A. Cranson, Honolulu Oil Corporation; W. C. Dayhuff, California Natural Gasoline Association; B. E. Devere, Pathfinder Oil Company; H. C. Farquhar, Union Oil Company; R. E. Fenton, California Stripper Well Association; Stark Fox, Oil Producers Agency; Dana Hogan, San Joaquin Valley Oil Producers Association; C. A. Johnson, Holly Oil Corporation; J. Grover Kelly, Hillman Kelly Supply Company; D. S. Kilgour, California Oil and Gas Association; Ralph B. Lloyd, Lloyd Corporation; Martin Meers, Tide Water Associated Oil Company; Wm. H. Morgan, R. R. Bush Oil Company; D. B. O'Neill, Independent Refiners Association; H. F. Owens, Berry Oil Company; E. E. Pyle, chairman of the Production Committee, Fifth District; J. A. Smith, Independent Producers and Consumers Association; George Suman, Tide Water Associated Oil Company; George Trembly, Howard Supply Company, and W. C. Whaley, Barnsdall Oil Company.

## Fire Protection Body Revises Standards

Standards governing the installation and operation of gas systems for cutting and welding and also those for foam and carbon-dioxide fire-extinguishing systems were revised by the National Fire Protection Association at its 46th annual meeting held in Atlantic City, New Jersey.

The gas cutting and welding standards were revised as a result of the number of serious fires that have been caused recently by the careless use of this type of equipment. The Committee on Gases, of which H. E. Newell of the National Board of Underwriters is chairman, presented the report.

The fire-extinguisher system standards were revised in order to cover the new developments in this equipment. A. L. Cobb, of the Eastman Kodak Company, is the chairman of the Committee on Special Extinguishing Systems that presented this report.

David J. Price, of the U. S. Department of Agriculture, was elected president of the N.F.P.A. for the coming year.

## California Committee to Supply Price Data

Selection of a committee from 28 companies, to be represented by men of their own choosing, was made at a cross-section of the oil industry in the Subway Terminal Building, Los Angeles, California, recently, the committee to provide the Office of Price Administration with data requested by that office for its consideration of prices of California heavy crude oils.

W. H. Morgan, of the R. R. Bush Oil Company, was selected as chairman of the group, and presided during the nominations. Personnel of the committee will not be determined until the companies named have selected the men to represent them.

## San Joaquin Valley Chapter A.P.I. Meets

The regular meeting of the San Joaquin Valley Chapter of the American Petroleum Institute was held at the Standard 11-C meeting hall, Taft, California, on May 19.

The meeting was called to order by Chairman J. B. Wharton, with 175 members and guests present.

The minutes of the April meeting were read and approved. Chairman Wharton made the following announcements: A. F. Turman resigned from the advisory committee because of ill health. F. A. Heitmeyer, Standard Oil Company of California, was appointed to fill the vacancy. A. C.

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This table of nail sizes has saved many a pump from excessive pressures. For, as you can see, foolproof directions are right on the name plate of every SHEAR-RELIEF VALVE. After the valve has sheared the nail to relieve excess pump pressures, any field worker can determine the correct nail size by this table which gives respective shearing stresses in pounds of pressure.

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ONE HALF INCH LINE

A sturdy, finely-built tape that every busy oilman will want to carry. Jet black markings on the satin chrome finish are easy to read—even in poor light. Surface won't rust, crack, chip or peel. Genuine leather case. Folding flush handle is opened by a push pin. See the "Anchor" at your supply house and write for catalog.

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Wright, Shell Oil Company, Inc., was appointed to fill the vacancy on the advisory committee caused by the appointment of Fred E. Smith as vice-chairman.

Chairman Wharton introduced Vice-chairman G. O. Suman who presented the first three speakers on the program as follows:

Louis M. Dreves, assistant manager, Industrial Salvage Section, Bureau of Industrial Conservation, War Production Board, Los Angeles, who spoke on "Relation of Conservation of Oilfield Materials and Disposition of Scrap."

J. F. Netka, chief signalman, U.S.N., who presented two sound moving pictures of the United States Navy called "The Eyes of the Navy and American Sea Power."

W. H. Jackson, Axelson Manufacturing Company, Los Angeles, who talked on "Factors Affecting the Type and Material in Selecting the Proper Oil Well Pump," illustrated with experimental equipment.

Vice-chairman Suman introduced J. C. May, Tide Water Associated Oil Company, who presented the fourth speaker of the evening:

Henry Salvatori, Western Geophysical Company, Los Angeles, whose subject was "Seismic Exploration Methods."

## Navy Again Honors Bantam Bearings for War Work

For the second time in six months the Navy has expressed appreciation to employees and management of the Bantam Bearings Corporation, South Bend, Indiana, for an outstanding production record on work being done for the Navy by awarding the company the coveted "E" for excellence pennant with white star and fouled anchor, symbolic of an outstanding production record since the firm received an "E" pennant six months ago.

Lieut. Kenneth Keepers and Ensign E. C. Dollard presented the award as representatives of the 9th naval district.

In accepting the award on behalf of the Bantam Bearings organization, R. B. Nichols, vice-president and general manager of the company said: "This citation from the Navy Department is further evidence that our employees are keeping their promise to go all out for the war effort. Since the first "E" award was made we have been able to step up production in a marked degree, and I'm sure every man is ready to try again to better our record."

An additional white star can be added every six months that the company maintains its production record. The Bantam Bearings Corporation was among the first to receive the original "E" award and is one of four in the midwest to receive the additional star and fouled anchor pennant.

*(South Bend Tribune Photo)*

*R. B. Nichols, vice-president and general manager of Bantam Bearings Corporation, South Bend, Indiana, accepts on behalf of Bantam employees second Navy "E" award given the company in six months. Presenting the award are Lieut. Kenneth Keepers (center) and Ensign E. C. Dollard, representing the Navy Department*

## Oil Compact to Study Secondary Recovery, Pressure Maintenance

Secondary recovery and pressure maintenance, means whereby vast oil reserves may be recovered with minimum use of steel, will be studied at the summer quarterly meeting of the Interstate Oil Compact Commission in Lexington, Kentucky, June 19 and 20, Chas. L. Orr, secretary, has announced.

Because war shortages of steel have placed new emphasis upon secondary-recovery programs, the first national survey of all aspects of the subject will be made at the Lexington meeting of the Commission.

Each of the Commission's standing committees has chosen one phase of secondary recovery for study and report. Individual reports from the oil states will be gathered into a national survey during committee meetings June 19, and the entire picture will be presented the following day at the general session.

Accepted and approved engineering principles will be discussed and reported upon by the engineering committee. Legal aspects and principles of secondary recovery, repressuring, and cycling will be reported by the legal committee. The research and coördinating committee will present factual and technical data and make a nation-wide survey on secondary-recovery projects. State rules and regulations will be surveyed and reported by the regulatory practices committee.

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## Wilson Supply Appoints West Coast Distributor

The Wilson Supply Company of Houston, Texas, has appointed the Western Pressure Control Company of Los Angeles, California, as west coast distributor of Nixon Surface Control Gas Lift Equipment.

The Western Pressure Control Company has offices at 5700 Santa Fe Avenue, Los Angeles, from where sales and service work is carried on in the Los Angeles Basin area. An office also is maintained at Bakersfield, for servicing the San Joaquin Valley.

The Western Pressure Control Company represents Otis Pressure Control, Inc., in California and because of the nature of its work is thoroughly familiar with production problems and practices in all west coast fields. The company carries a complete stock of Nixon Surface Control Gas Lift Equipment and engineers are available at all times to discuss production problems, etc., and to service Nixon equipment when necessary.

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THE NATION'S OIL SUPPLY
OTIS TUBING SAFETY VALVE
Just like the sentry walking his post, whose first general order is:
"To take charge of this post and all government property in view."
. . . the Otis Tubing Safety Valve is the sentinel of our oil and gas reserves—on 24-hour duty and no relief.
Constantly on guard, but never seen, the Otis Tubing Safety Valve is installed at a safe sub-surface level, automatically shutting off all flow through the tubing the instant surface connections are damaged from any cause.
Right now we have bombs in mind. But the valve is still effective in wells located in water where high wind or a stray barge might damage surface connections or in congested areas and towns where property and human lives are at stake.
The Otis Tubing Safety Valve is available in two types—the Type C is actuated by Pressure Differential and is adaptable to all flowing conditions. The Type B is actuated by Flow Velocity and is best adapted to wells with steady flow.
Check with your nearest Otis Representative or write direct for complete information and details.
OTIS PRESSURE CONTROL, INC.
DALLAS, TEXAS
PRESSURE CONTROL OTIS SERVICE - EQUIPMENT
Branches: Houston, Texas; Hobbs, New Mexico; New Iberia, Louisiana
Representatives: Otis Eastern Service, Inc., Wellsville, New York; Western Pressure Control, Los Angeles and Bakersfield, California
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# STOP Loading Rack LOSSES

EQUIP your Loading Racks with CHIKSAN Ball-Bearing Swing Joints NOW and stop losses due to leaks or high maintenance costs. Lengthen the life of your rubber hose by using CHIKSAN Joints as flexible end connections.

Style 30X4

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NOTHING TO TIGHTEN OR ADJUST—No packing glands to keep tight. No constant maintenance attention required.

EASY OPERATION—No sticking or binding in any climate. Full 360° rotation in 1, 2 and 3 planes, on double rows of steel balls.

FOR PRESSURE OR SUCTION—CHIKSAN Swing Joints are equally effective on both loading and unloading lines or for underwater installations.

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OPTIONAL END CONNECTIONS—Supplied with threaded or flanged ends or bored for welding. Made of malleable iron or steel. Sizes from 2" to 6".

IMPERVIOUS TO MATERIALS INJURIOUS TO RUBBER—Special packing sets for handling fluids and gases which are injurious to ordinary fabric hose.

FOR EVERY APPLICATION—CHIKSAN Swing Joints are used on Loading Racks for trucks and tank cars, in barge hose and as dock risers—wherever flexible lines are required.

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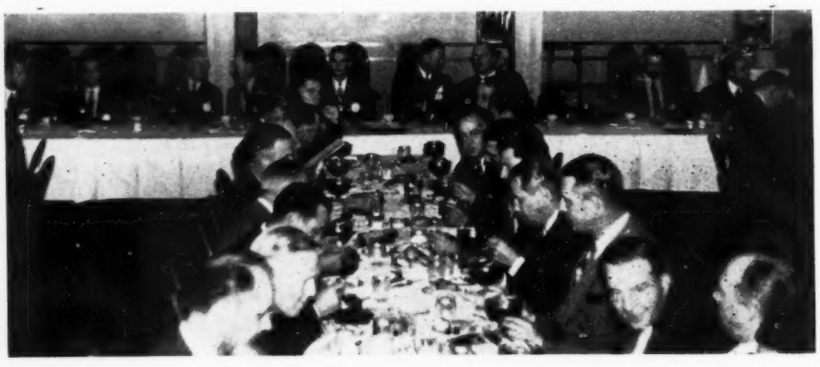
BALL BEARING SWING JOINTS for ALL PURPOSES

BREA, CALIFORNIA

ALL-STEEL ROTARY HOSE
CIRCULATING HEADS · MUD GUNS


## Los Angeles Nomads Meet During Foreign Trade Week

Holding the regular monthly dinner meeting during National Foreign Trade Week, the Los Angeles Chapter of Nomads met at the Mayfair Hotel in Los Angeles, May 20. Many interesting guests were present and the attendance was so large that overflow tables had to be provided. The main speaker of the evening was W. S. Rosecrans, president of W. S. Rosecrans, Inc., a man long connected with various California industries who has traveled in many countries in the interest of foreign trade. Rosecrans discussed the vital necessity of international trade after the war and in his address pointed out that intelligent, constructive criticism must be carried on now if the kind of peace we all desire is to result from the present conflict.



*Los Angeles Chapter of Nomads Dinner*

Awards for distinguished service were presented to the regular Nomad members by Emerson Spear in behalf of the Los Angeles Chamber of Commerce, which, during Foreign Trade Week, so honored men who had traveled abroad in the interest of foreign trade. These awards were attractive parchment diplomas suitable for framing.

Preceding the main address the several members of the consular service present from a number of foreign countries were introduced by Bart Gillespie. These were Dr. Adrian Hartog, consul of the Netherlands; Alastair G. Maitland, vice-consul for the British Empire; Ernesto A. Romero, vice-consul of Mexico; Ismael Aviles, consul of the Dominican Republic; Fernando de Flores, vice-consul of Costa Rica, and Carlos Cavalcanti, secretary to the Venezuelan consulate.

The meeting closed with moving pictures in colors shown by George Sutherlen who took them in Tibet, Nepal, and India during a vacation when he was with the California Arabian Standard Oil Company in Saudi Arabia. Of particular interest was the stark beauty of Mt. Everest taken with a telephoto lens.

The foreign oil men present included M. H. Bush of California Arabian Standard Oil Company from Saudi Arabia; W. C. Field who was with the N.P.P.M. in Sumatra; Dirk Kwakernaat of the Caribbean Petroleum Company, Venezuela; H. J. Buddenhagen of the Shell interests, Maracaibo, Venezuela; Alfonso Cesario Alvim, Luiz Meira de V. Chaves, and Geonisio Carvalho Barroso of the Conselho do Petroleo, Brazil. Other guests were Walter Measday of the U. S. Department of Commerce; Stanley T. Olafson, manager of Department of Foreign Commerce, Los Angeles Chamber of Commerce; Al Hill of the Los Angeles Chamber of Commerce, and Charles J. Hoffman recently returned from Panama.

## Foxboro Employees Observe 25-Year Milestone

Employees of The Foxboro Company who have completed 25 years or more in its service were guests of the company at a celebration, held at the main office, Foxboro, Massachusetts, on the evening of May 26. A jeweled service pin of gold was presented to each of the 50 men and women thus honored, and a program of entertainment, supplemented by the reminscences of old-timers, made the occasion an enjoyable one.

Almost another 50 employees have service records that are within a few months of the quarter-century mark; and it is therefore assured that similar celebrations will be held annually, hereafter, to welcome new members as they qualify.

The Foxboro Company, makers of instruments for process measurement and control, was organized in 1908 as the Industrial Instrument Company, but adopted its present name in 1912. The company maintains 28 district offices in the United States and branch factories at Pittsburgh, Dallas, and San Francisco, and has complete factories in Montreal and in London, England, and representatives in all parts of the world.

## A. E. Crockett Passes Away

A. E. Crockett, 69, special sales representative for the Jones and Laughlin Steel Corporation, died recently after a short illness.

Crockett had been associated with Jones and Laughlin since May, 1915, when he joined the organization as an engineer. In 1919 he was appointed

A. E. CROCKETT

manager of the Bureau of Instruction and later was made special sales representative. He devoted himself primarily to educational work, lecturing at colleges and before engineering and technical societies on the manufacture of iron and steel products. He was widely known throughout the United States but particularly in the oil country where he was regarded as one of the most interesting speakers on steel to appear in those districts.

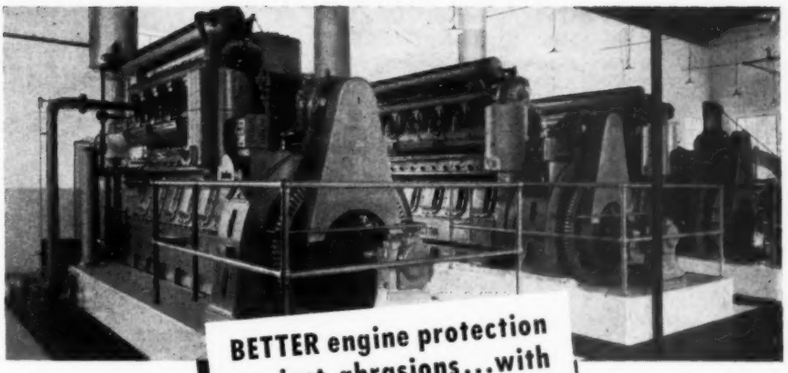
## R. F. Bergmann Link-Belt Chief Engineer

Announcement is made by Link-Belt Company that Richard F. Bergmann has been appointed chief engineer for the company, with offices at executive headquarters in Chicago.

William W. Sayers, who has served in this capacity since 1925, has been appointed consulting engineer. Bergmann was assistant to Sayers from 1933 to 1936, when he resigned to become chief engineer of Rayon Machinery Corporation, Cleveland, Ohio, from which position he now returns to Link-Belt.

He is a native of Logansport, Indiana, was graduated from Rose Polytechnic Institute at Terre Haute, Indiana, in 1918, and joined Howe Chain Company, Muskegon, Michigan, after brief service as an ensign in the U. S. Navy during World War 1.

After merger of Howe Chain Company with Link-Belt Company, he was transferred to Chicago in 1924, first becoming chief engineer of the Link-Belt Caldwell plant, and in 1933, assistant to the chief engineer of the company.

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Engines weren't made to handle dirt and grit on cylinder walls, valves, pistons, or in the crankcase. Yet abrasives can easily reach these vital parts through the air intake . . . *unless you safeguard your equipment with Vortox Air Cleaners.*

These cleaners cut dust intake to an absolute minimum, without restricting air flow. They maintain high efficiency at fast, slow, or fluctuating speeds. And by protecting internal parts against wear, Vortox Cleaners keep engine efficiency up and help make parts last longer.

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VORTOX OIL TYPE SELF-WASHING AIR CLEANER

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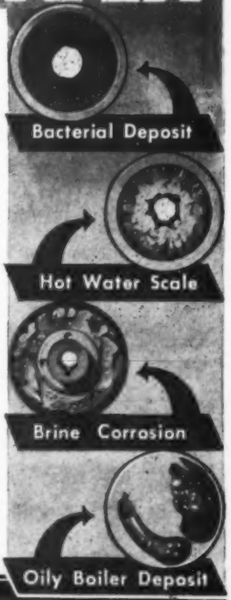
There are a great many stories that can be read in the various samples of water we receive. They tell of scale and corrosion in varying degrees of destructiveness. Water for cooling systems, steam and return systems, refrigerating brines . . . each has its particular story. Power plants, petroleum industries, process industries, public buildings and transportation industries . . . all have their problems.

Let us study these problems for you and tell you how Chrom Glucosate, Phospo Glucosate, and many others of our Haering products can correct these conditions, saving your materials and increasing the production of your plant.

*Write for these interesting booklets:*
**"Organic Methods of Scale & Corrosion Control"**
**"Cooling Waters" • "H-O-H Lighthouse Reprints'**
**"The Solution of Your Proportioning Problem"**
and other booklets on water treatment for Power Plants, Refrigeration Plants, Petroleum Industries, Process Industries, Public Buildings, and Transportation Industries.

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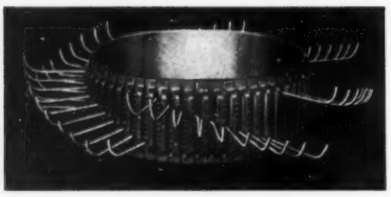

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FOR CEMENTING

DEEP WELLS

**THE QUESTION** is sometimes asked. **"Are B and W Wall Cleaning Guides safe to use in deep well operations, where high temperatures make thicker mud cake and all conditions are more severe?"**

**We're happy to say that B and W Guides take deep wells "in their stride", removing mud cake, centering casing and safeguarding the primary cement job just as easily as in shallow wells. *Here are just a few of our many deep jobs:***

| DEPTH | NO. OF GUIDES | SIZE CASING |
|---|---|---|
| 13150' | 12 | 4¾" |
| 11744' | 46 | 5½" |
| 10875' | 30 | 7" |
| 10500' | 33 | 7" |
| 10419' | 33 | 7" |
| 10000' | 48 | 5½" |
| 10000' | 15 | 5½" |
| 9800' | 40 | 5½" |
| 9700' | 106 | 5" |

**WHETHER YOU'RE DRILLING deep or shallow wells, B and W Guides will help you prevent fluid migration and reduce the danger of costly re-cement jobs. Our Bulletin 102 gives complete information on their usages. *Send for your copy.***

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## F. D. Mahone Dies At Long Beach

F. D. MAHONE

Francis D. "Jim" Mahone, assistant chief and design engineer of the Petroleum Rectifying Company of California, died at the Community Hospital in Long Beach, California, May 16. Of late, Mahone's duties kept him closely associated with the Petreco Long Beach headquarters. In years past he had carried on engineering work for Petreco in foreign countries, and in major fields throughout the United States. He was respected as an extremely resourceful and competent engineer, and his friendship was valued by many men in the industry. He attended Stanford University and served as a captain in the United States Field Artillery during World War I.

## See Diesels in the Making

As a part of the two-day spring meeting of the Society of Naval Architects and Marine Engineers, held at Pittsburgh, Pennsylvania, on May 26 and 27, many of those attending visited the Pennsylvania plant of The Cooper-Bessemer Corporation. As guests of the engine builders, the purpose of their visit was to see just what goes into the making of the marine Diesel engines that the company is producing in greater quantities than ever before for Coast Guard, Maritime Commission, and U. S. Naval vessels.

Transported by bus and automobiles from their headquarters in Pittsburgh, to the Penn-Grove Hotel in Grove City, forty-some visitors and 20 company representatives were served luncheon in the ballroom and addressed briefly by B. B. Williams, president, and Gordon Lefebvre, general manager, of the Diesel engine manufacturing concern. They were then conducted on a tour of the company's foundries, machine shops, assembly floors, and test departments.

Among the ranking naval officers, engineers, and architects present were Captain P. B. Eaton and Lt. Comndr. E. M. Kent of the U. S. Coast Guard; Lt. Comndr. F. B. Hays, Lt. R. J. Sumner, and H. B. Gregory of the U. S. Navy, Bureau of Ships; Comndr. W. F. Jamison of the British Royal Navy and British Embassy and W. R. Watson of the British Merchant Navy; Hugo Haas, naval architect from the office of the Quartermaster-General-War Department; John H. Wells and T. R. Tarn, well-known naval architects, Daniel J. Brown and James Young of Pusey and Jones, shipbuilders, and Prof. H. L. Seward of Yale University.

*Viewed making of Diesel engines*

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## "Elimination of Oxygen Waste" Campaign

As part of a campaign against waste of oxygen in welding and cutting operations, two posters for display in plants where oxy-acetylene processes are used have been made available. (See accompanying illustrations.) Both posters dramatize oxygen's importance to war production and emphasize the need for its conservation. Eye-catching colors and illustrations give both pieces high attention value.

OXYGEN is vital . .
DON'T WASTE IT
Turn off torches when laying out work
Do not use wasteful pressures or oversize tips
Check hose and connections regularly for leaks
Use all the gas in each cylinder before connecting a new one
Close cylinder valves when not in use
Keep tips clean
Be sure equipment is in good working order
Help your pals in the Armed Services
FIGHT WASTE

No advertising appears on either poster. Light-weight paper stock permits easy mounting anywhere in the shop. Free copies will be sent postpaid in any quantity desired. Address G. Van Alstyne, Air Reduction Sales Company, 60 East 42nd Street, New York, New York.


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**PIPE CUTTERS**

The Drop-Forged and "Combination" Pipe Cutters can be used as a 1 or 3 wheel cutter. All are improved cutters, accurately made with hardened steel pins and rollers. Thrust rods of "Saunders" type cutter are hardened at the point and bear on embedded, hardened steel block. On "Barnes Type," the thrust is taken up by drop-forged steel sections. Parts are interchangeable with other standard makes.

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NATIONWIDE SALES AND STOCKS

## GE Motor Division Executives Advanced

C. F. Pittman, manager of the motor division of General Electric's industrial department, has been named assistant to the manager of the industrial department, according to an announcement by Commercial Vice-President J. E. N. Hume. W. H. Henry, who was manager of sales in the motor division, succeeds Pittman as manager of the division.

Pittman, a native of Kansas, became associated with General Electric as a student engineer in 1911 immediately after being graduated from Purdue University. Prior to his appointment in 1929 as manager of the motor division, he had had extensive experience in many General Electric departments.

Henry was born in Terre Haute, Indiana, and was graduated from Rose Polytechnic Institute in 1914. After five years of commercial work with the Western Electric Company, he joined General Electric in 1919 as a sales engineer. Since 1928 he has been closely allied in different capacities with the sales of motors.

## Humble Men Conduct Conference Course

Forty-one employees of the East Texas gasoline plants of the Humble Oil and Refining Company were awarded certificates by the company in recognition of the work they have done in conducting a conference course in gasoline plant operation. The certificates were presented by J. O. Sue of Houston, superintendent of the Natural Gas and Gasoline Department of the company, at a barbecue supper that was given at the recreation hall at New London on May 23.

The primary purpose of the course was to familiarize the employees with all details of operation of modern plant equipment.

At the request of the employees, the course was planned by the plant superintendents under the direction of R. E. Buckner, division superintendent at Overton. It was a seminar type course, in which the men on each shift worked together as a group to prepare and present the subject matter for the meetings.

The course was conducted for nine months, so that each group could have an opportunity to make a drawing of each division of the plant, and lead a discussion on that subject.

That course laid the foundation for another course that the men are studying at the present time, one on industrial defense fire-fighting methods.

The following received certificates: At the American Plant, William H. Baldwin, John R. Carroll, Bernie T. DeMent, James D. Hedgecock, W. L. Lain, Mark Allen Mills, Monroe S. Upchurch, Harry P. Walker, L. Wayne Walker, James V. Ware, and Maurice A. Yowell.

*Group at Humble Conference Course on gasoline plant operation*

At the Kilgore Plant: James Arnold Ates, Oran R. Hawkins, Cecil H. Hilliard, Newton M. Kunkle, Oliver P. Laurenee, Thomas R. McEachern, Harry Magness, Curtis K. Mercer, H. Ford Rackley, John E. Rankin, Marion L. Suttle, and Edmond B. Woodell.

At the London Plant: Walter B. Burgess, Jessie P. Carroll, C. B. Couch, James M. Diamond, C. Clay Emde, Wayne Foster, Jr., Robert Gentry, William D. Gray, Charles H. Harden, William A. Marsden, Willis R. Mathyer, John M. Simmons, Jr., Felix F. Sparks, Thomas A. Stevens, Edwin C. Tomlin, John Willis, Ira T. Wright, and Wylie B. Wyatt.

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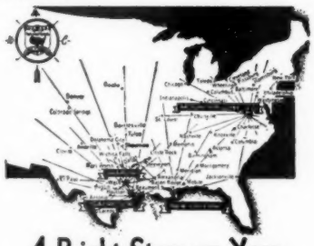

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Hotel Stephen F. Austin . . . . . Austin
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Hotel Settles . . . . . Big Spring
Hotel Brownwood . . . . . Brownwood
Hotel Southern . . . . . Brownwood
Hotel Laguna . . . . . Cisco
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Hotel Galvez . . . . . Galveston
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## Oil-Field Photograph Free on Request

The Continental Supply Company, Dallas, Texas, is offering to send free to anyone in the oil industry requesting it a print suitable for framing of a particularly striking oil-field photograph. The photograph, of an old bull wheel, may be seen on page 73 of this issue of *The Petroleum Engineer*. The picture sent will be a 11 by 11 Brown Duotone print.

This year marks Continental's thirtieth anniversary as a supplier of oil-field equipment.

## Diesel Engine Corporation Announces Change in Name

The Rogers Diesel And Aircraft Corporation on June 1 became the new corporate name of The Cummins Diesel Engine Corporation of New York. The corporation operates two New York plants, 1120 Leggett Avenue, and 724 Garrison Avenue, with offices situated at the former address.

Originally formed in 1934 as a distributing organization for Cummins Diesel engines, the corporation has since enlarged its scope of operations and its facilities to the point where a new corporate name was needed to describe more adequately the nature of its business.

Although continuing as a distributor for Cummins engines, Rogers Diesel And Aircraft Corporation now represents Enterprise and Sheppard Diesel engines also, and, in addition, manufactures a complete line of gasoline and Diesel-driven generator sets and power and pumping units.

In announcing the adoption of the new name, Ralph B. Rogers, president of the corporation, said that "The new corporate name does not mean that any re-organization or change of ownership has taken place. Management, products, and policies are in no way affected."

In addition to its two New York plants, Rogers Diesel And Aircraft Corporation is engaged in manufacturing activities in two other states. In 1940, it purchased the Edwards Company of Sanford, North Carolina, manufacturers of railway motor cars and aircraft equipment, and a year later —through the Edwards Company—acquired control of the Hill Diesel Engine Company of Lansing, Michigan.

Although these two subsidiary companies retain their respective company names, they will now be further identified as divisions of Rogers Diesel And Aircraft Corporation. Executive offices of all the companies are situated at the new Leggett Avenue plant in New York.


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The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a garter spring having minimum tension.

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# TRADE LITERATURE

## What to Write For

REALIZING that the maintenance man now has one of the most important jobs in the petroleum industry, Westinghouse Electric and Manufacturing Company has issued two volumes entitled "Maintenance Hints." The books contain practicable and timely suggestions on the care and maintenance of electrical equipment. Both volumes are pocket size. Vol. 2 is loose-leaf so that additional bulletins may be added as published. "Maintenance Hints" are free to all maintenance men and their names also will be added to the company's mailing list to receive additional bulletins to go in the loose-leaf volume. Address Westinghouse Electric and Manufacturing Company, Dept. 7-N, Maintenance Sales Department, East Pittsburgh, Pennsylvania.

THE FRANCE PACKING COMPANY, Tacony, Philadelphia, Pennsylvania, is sending free on request a 44-page catalog, M-3, on packing designs for any service, installation procedure, methods of lubrication, pressures and temperatures, oil return and stripping rings, and containing handy reference tables.

BULLETIN T-1041 on "How to Protect Your Tool Joint Investment" is offered free by the Reed Roller Bit Company, P. O. Box 2119, Houston, Texas.

B AND W, INC., Long Beach, California, and Houston, Texas, has issued Bulletin 102 that gives complete information on usages of Wall Cleaning Guides. Copies are being sent upon request.

E. D. BULLARD COMPANY, 275 Eighth Street, San Francisco, California, is distributing a new folder describing personal safety equipment.

FLUOR ATMOSPHERIC COOLING TOWERS are described in Bulletin T-337, issued by The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles, California.

THE FOXBORO COMPANY, 130 Neponset Avenue, Foxboro, Massachusetts, is mailing free upon request Bulletin 200-6, which gives details of its flow recording equipment.

INFORMATION on pipe protection is contained in a booklet entitled "The Book of Pipe Protection." Copies can be obtained without obligation from General Paint Corporation, Hill, Hubbell and Company Division, Cleveland, Ohio.

D. W. HAERING AND COMPANY, 205 West Wacker Drive, Chicago, Illinois, has available several interesting booklets, as follows: "Organic Methods of Scale and Corrosion Control," "Cooling Waters," "H-O-H Lighthouse Reprints," and "The Solution of Your Proportioning Problem."

"FLEET-FILLET" Bulletin 432 may be obtained from The Lincoln Electric Company, Cleveland, Ohio. This publication discusses stepping-up of welding output by the new "Fleet-Fillet" technique.

BULLETIN WF-41, issued by Midwest Piping and Supply Company, 1450 South Second Street, St. Louis, Missouri, discusses features of Midwest Elbows and the Midwest Welding Fittings. Write for a copy.

LINE PIPE made by the Republic Electric Weld Process is described in a 44-page book entitled "The Pipe of Progress." Copies may be obtained from Republic Steel Corporation, Cleveland, Ohio.

UNITED STATES RUBBER COMPANY, 1230 Sixth Avenue, New York City, has available a 48-page book on methods of conserving mechanical rubber goods. For free copies write direct to the Mechanical Goods Division of the company.

TUBE-TURNS, INC., 224 East Broadway, Louisville, Kentucky, has issued the first number of a new quarterly publication called Tube Turn Sparks. This first issue is devoted to welding's vital role in the battle of production.

THE BROWN INSTRUMENT COMPANY has issued a revised catalog on Brown Potentiometer Pyrometers, No. 1105. This catalog presents clear and concise information on the design and operating features of the Brown Potentiometer Pyrometer and Accessory Equipment. Copies will be sent on request. Address The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, and ask for Catalog No. 1105.

## Auto, Plane, and Oil Industries Set Up New Research Organization

Automobiles, airplanes, tractors, and other vehicles of the future will operate better because of the work of a new organization that will coördinate the research activities of the automotive, aeronautic, and petroleum industries.

The best combinations of fuels, lubricants, and equipment powered by internal combustion engines will be sought by the new group, the Coöperative Research Council. The council, which is sponsored by the American Petroleum Institute and the Society of Automotive Engineers, will continue the work of the Coöperative Fuel Research Committee. The CFR committee has done effective research on fuel utilization for 21 years, and its work has been of major importance in the development of automobile and airplane engines and fuels to their present state of perfection.

Other council groups that will centralize, correlate, and promote coöperative research within these industries include a coöperative lubricants research committee, a coöperative equipment research committee, and a war advisory committee. The latter will work with government and military agencies in solving fuel and lubricant problems. The council will not issue any standard methods of test, specifications, or classifications. These already are the function of existing agencies.

The membership includes six each from the A.P.I. and the S.A.E. The A.P.I. members are:

D. P. Barnard, Standard Oil Company (Indiana); A. L. Clayden, Sun Oil Company; T. G. Delbridge, The Atlantic Refining Company; R. A. Halloran, Standard Oil Company of California; K. G. Mackenzie, The Texas Company, and G. G. Oberfell, Phillips Petroleum Company.

The S.A.E. representatives are:

B. B. Bachman, Autocar Company; J. M. Crawford, Chevrolet Division, General Motors Corporation; William Littlewood, American Airlines, Inc.; J. B. Macauley, Jr., Chrysler Corporation; Arthur Nutt, Wright Aeronautical Corporation, and C. G. A. Rosen, Caterpillar Tractor Company.

At the organization meeting, Bachman was elected chairman and Delbridge vice-chairman. C. B. Veal, for 16 years research manager of the S.A.E. and secretary of the CFR committee, has been appointed secretary, and R. P. Anderson, secretary, Division of Refining, of the A.P.I., is treasurer. Headquarters have been established at 30 Rockefeller Plaza, New York City.


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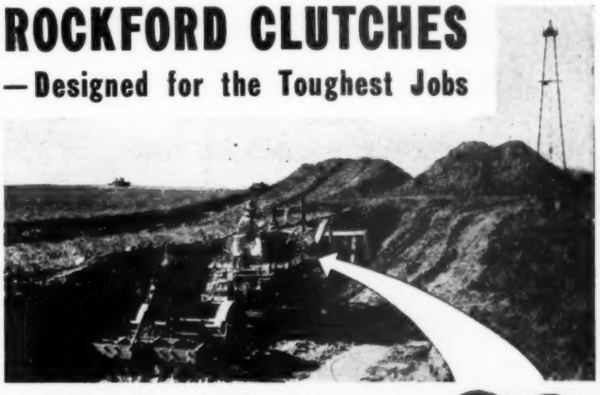

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A Rockford Over-Center Clutch in main drive of tractor illustrated promotes continuous performance that gets work done faster at lowest cost on excavating, grading, road work, towing or any tough tractor-job.

Rockford Over-Center Clutch

Rockford Plate Clutches are noted for outstanding performance on industrial applications; including tractors, power units and specialized equipment for the oil industry. Made in Over-Center and Spring-Loaded types, in many standard sizes, they meet the most exacting requirements. O-C type locks in and out of engagement; Spring-Loaded works like an automobile clutch.

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# Book Reviews

*Technidata Hand Book*, by Edward L. Page. Published by the Norman W. Henley Publishing Company, 17-19 West 45th Street, New York, New York. Spiral binding price, $1.00; cloth binding price, $1.50.

"As a student, the author found himself carrying around too many books and spending too much time looking through them for information which often proved to be scattered elsewhere. He compiled for his own use the data contained in this book which in its compactness contains nearly all the essential information needed on these subjects."

The book has been written for all who use their knowledge of mathematics, physics, chemistry, mechanics, or engineering. All the essentials of books on geometry, algebra, trigonometry, calculus, physics, chemistry, and mechanical engineering are presented in the book in a relatively few well-organized pages.

Facts, figures, theory, definitions, laws, formulas, sample calculations, diagrams, and tables are all utilized. The formulas have short explanations of terms with the units and common constants given. All information is basic and will not go out of use.

•

*Introduction to Heat Transfer*, by Aubrey I Brown and Salvatore M. Marco. Published by McGraw-Hill Book Company, Inc., New York, New York. 232 pages. Price, $2.50.

The authors of this book have intended it as a text in which the fundamentals of heat transfer are presented in a manner readily understandable to engineering students and engineers in practice who have completed courses in physics and mathematics usually required in the first two years of engineering curricula and an elementary course in heat power.

Development of the subject of heat transfer has proceeded along three distinct lines beginning with the studies of the ways in which heat is transmitted, by the formulation of mathematical expressions that take into account the various factors that have been found to influence the rate of transfer, and thirdly by the accumulation of experimentally determined coefficients and constants for substitution into these mathematical expressions.

In the book emphasis has been placed upon acquiring a clear conception of the manner in which heat is transmitted and upon the development of the fundamental mathematical expressions that apply to the calculations of heat transfer through clean surfaces. Most of the material presented in the book has been used with satisfactory results in a required course for third-year mechanical engineering students at The Ohio State University, following a course in fluid mechanics and several courses in heat power.

•

*Colorado School of Mines Quarterly*. Volume 37, Number 2. *The Oil and Gas of Colorado*. By Clark F. Barb. Published by The Colorado School of Mines. Single copy $2.00; 129 pages.

This issue of the Quarterly contains the first complete record of the oil and gas industry in Colorado, including a history of the industry in the state, a detailed description with production and geologic data of every oil field, estimates of oil and gas reserves, secondary-recovery reserves, oil production costs, descriptions of each refinery, crude-oil analyses, oil consumption, markets, pipe lines, natural gas, oil shale and coal substitutes in Colorado, and a digest of the petroleum laws. Bibliographies follow each major subject.

# MEETINGS

American Society for Testing Materials—June 22, 23, 24, 25, and 26, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

California Natural Gasoline Association, Monthly Meeting—July 2, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

Indiana Independent Petroleum Association, Fall Meeting—September 14 and 15

National Petroleum Association, Annual Meeting—September 16, 17, and 18, Hotel Traymore, Atlantic City, New Jersey.

National Safety Congress and Exposition—October 5, 6, 7, 8, and 9, Stevens Hotel, Chicago, Illinois.

Texas Mid-Continent Oil and Gas Association—October 8, 9, and 10, Dallas, Texas.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, Rochester, New York.

Indiana Independent Petroleum Association—October 14 and 15, Hotel Severin, Indianapolis, Indiana.

National Stripper Well Association, Annual Meeting—October 19, Wichita, Kansas.

Independent Petroleum Association of America, 13th Annual Meeting—October 20, 21, and 22, Wichita, Kansas.

National Lubricating Grease Institute, Tenth Annual Meeting—October 25, 26, 27, 28, and 29, New Orleans, Louisiana.

Illinois Mineral Industries Conference—October 30 and 31, Urbana, Illinois.

American Petroleum Institute, Annual Meeting—November 9, 10, 11, 12, and 13, Chicago, Illinois.

American Institute of Chemical Engineers, 35th Annual Meeting—November 16, 17, and 18, Netherland Plaza, Cincinnati, Ohio.

American Chemical Society, National Chemical Exposition and National Industrial Chemical Conference—November 17, 18, 19, 20, and 21, Stevens Hotel, Chicago, Illinois.

American Society of Mechanical Engineers, Annual Meeting—November 30 and December 1, 2, 3, and 4, New York, New York.

## Death Calls Cary D. Waters

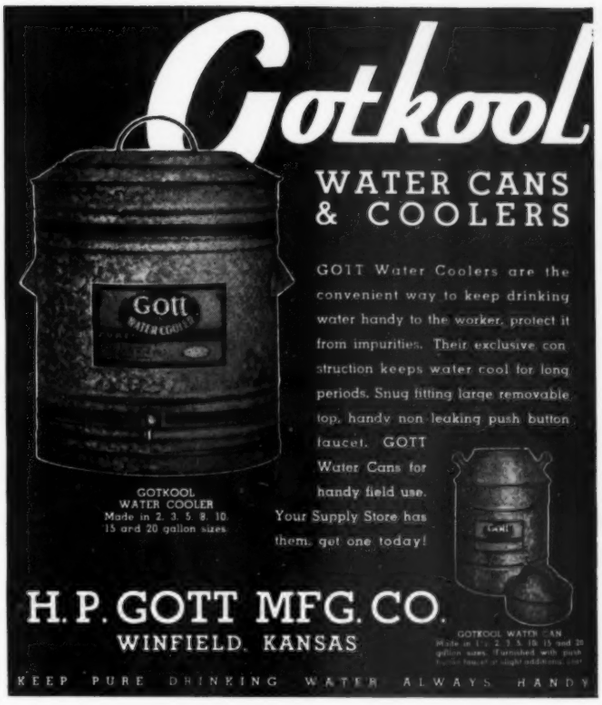
Cary D. Waters, Brooklyn, New York, business executive and president of the C. J. Tagliabue Manufacturing Company, died at his home recently. He was 58 years old.

Waters was born in 1883 in Norwich, New York, a descendant of a colonial New England family. He was educated at Hamilton and Pratt Institutes in Brooklyn and was graduated from New York University in 1904.

He began his business career as the superintendent of the Empire Pipe Corporation of Brooklyn, and became its president in 1908, remaining in the post until the company was dissolved in 1938. For the last 20 years he has been president of the C. J. Tagliabue Manufacturing Company, of Brooklyn.

From 1936 to 1940 he served as president of the Brooklyn Chamber of Commerce, having previously been director for three years. Later, as chairman of the chamber's executive committee, he was active in mobilizing the borough's industrial plants for conversion to preparedness work. For such and similar "distinguished services" to the borough the Downtown Brooklyn Association awarded to him its gold medal in January, 1941.

He was chairman of the board of trustees of the East Brooklyn Savings Bank, a member of the Brooklyn advisory board for the Chemical Bank and Trust Company, a director of the Home Title Guaranty Company, and a trustee of Adelphi Academy, Packer Collegiate Institute, and the Industrial Home for the Blind. In 1931 and 1932 he was Mayor of Shoreham, Long Island, where he had a summer home.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